Boiler Maker and Plate Fabricator

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PERSONAL

Boiler Maker and Plate Fabricator

Relation of Locomotive Maintenance to Safety

As might be expected, locomotive accidents during the fiscal year 1934 were on the increase, although the consequent casualties showed a decline over the previous year's figures. In his annual report to the Interstate Commerce Commission A. G. Pack, chief inspector of the Bureau of Locomotive Inspection, points out that whatever progress in locomotive maintenance may have been made as compared with records of years past there cannot be a lapse such as that since 1932 without retrogression in the direction of safety. His analysis of the situation is contained in the following statement:

"During the year 12 percent of the steam locomotives inspected by our inspectors were found with defects or errors in inspection that should have been corrected before the locomotives were put into use, as compared with 10 percent in the previous year, and 8 percent in the year ended June 30, 1932. The increase in the percentage of locomotives found defective was brought about by the action of the railroads in drastically curtailing their maintenance forces over the period affected and, in general, performing only such work as appeared to them to be immediately necessary for the time being. The effect of this policy was to produce a considerably greater recession in the condition of locomotives over the two-year period, and especially for the year just passed, than is indicated by the increase in the percentage found defective because of the accumulated wear of major parts which would otherwise have been restored currently. There was an increase of 38.6 percent in the number of locomotives ordered withheld from service by our inspectors because of the presence of defects that rendered the locomotives immediately unsafe, as compared with the previous year, an increase of 31.3 percent in the total number of defects found, and increases in individual items found defective ranging from 3 percent to 149 percent."

If the record indicates anything it demonstrates the fact that adequate and proper locomotive maintenance depends on the current status of business. This most essential element of successful railroad operation has certainly been on a depression basis. It is amazing that this record of safety could be made in the face of the handicaps imposed.

The future offers no certainty that the present maintenance policies can be continued with the same results. Already since the close of the period covered by the report, there have been several locomotive accidents with a loss of life and serious injuries that will overcome the progress of several years made in the direction of safety. Two locomotive accidents alone in recent months, both caused by boiler explosions, have entailed the loss of sixteen lives and serious injury to forty-two persons.

To avoid further drastic occurrences during the fiscal year 1935, eternal vigilance is necessary, from the mechanical officers down to the man on the job. Whatever the financial status of the railroads may be, they must maintain their equipment if they would continue in public confidence. Funds should not be applied to the construction of flashy, publicity-attracting locomotives or train units at the expense of essential work on the motive establishment as a whole.

Replacement of obsolete and unsafe equipment is necessary but so too is the rehabilitation of the 10,000 locomotives now in unserviceable condition throughout the country.

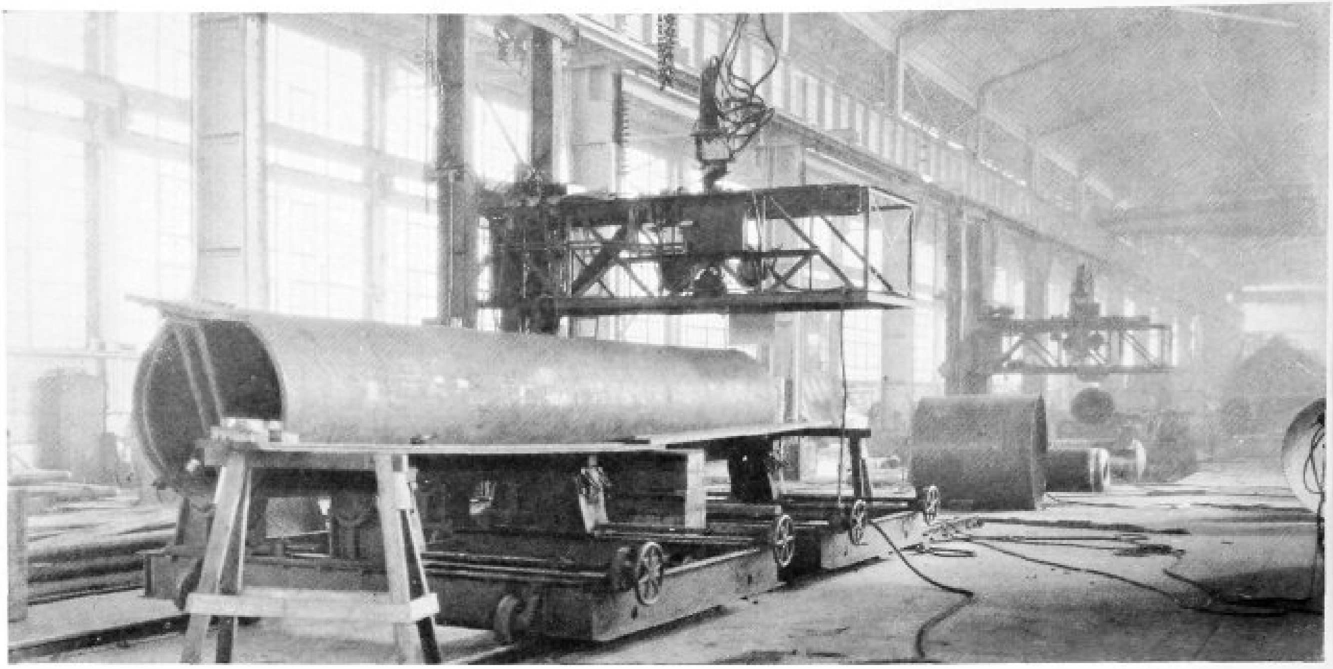
Welding As a Tool for Industry

Fusion welding, which during depression years has advanced so tremendously as an accepted means of joining metal structures, is entering the period of recovery in heavy industry as a tool that more and more will tend to revolutionize conceptions of design in almost every field.

Having its humble beginnings in the railroad shop, the applications of welding were comparatively few until 1925. Since then, and particularly since 1930, its advance has been tremendous. In the pressure vessel field the action of the American Society of Mechanical Engineers in establishing a Code for Unfired Pressure Vessels opened the way for the fabrication of an almost innumerable variety of vessels used in industrial processing operations. The work of the Boiler Code Committee, the American Welding Society and other groups in fostering growth in the art of welding with safety is an outstanding contribution to industry as a whole. Since no more drastic service can be conceived nor one in which the potential hazard is greater than in the case of pressure vessels, either boilers or of the unfired type, the developments in welding made in this field can now be applied with safety in the fabrication of practically any industrial structure.

The fact must never be forgotten that only by the use of proper equipment and materials in the hands of competent operators can welding of the quality demanded by safety be realized. Details of the type of equipment and the procedure followed by one of the very few concerns qualified to carry out Class-I pressure vessel welding are given in this issue. In addition to work of this nature, this concern is one of three authorized by the Navy Department to fabricate welded drums for naval boilers.

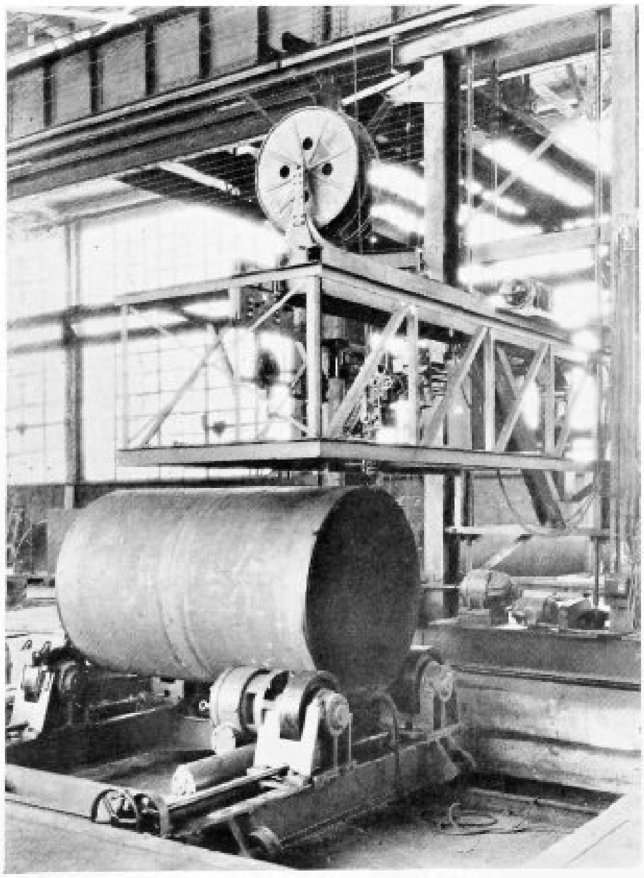
The success of this and other plants depends upon a combination of designing skill, modern welding equipment, testing facilities and properly trained and competent operators. These are the fundamental principles which must be applied wherever the process is adopted. The field of heavy-plate fabrication has constituted the proving ground of welding for all industries.



Class-1 pressure vessel fabricating shop of Foster-Wheeler at Carteret, N. J.

Use of automatic A-C arc for

WELDING CLASS—I PRESSURE VESSELS*



By O. A. Tilton†

In the field of electric arc welding, development has been so rapid in the past ten years that we are accustomed to consider practices which have been in effect from two to four years, as old and established customs. It may, therefore, be stated that automatic welding of Class I pressure vessels with alternating current is not new. However, this thought should be qualified by the statement that it is only quite recently the automatic equipment, transformers, electrodes and procedure have become generally available for industry through the developmental effort of concerns which are in the field of commercial exploitation of welding.

Alternating current welding, in itself, has been known

* Abstract of a paper presented at Fall Meeting, American Welding Society, in New York, October, 1934.

† Industrial Engineering Department, General Electric Company.

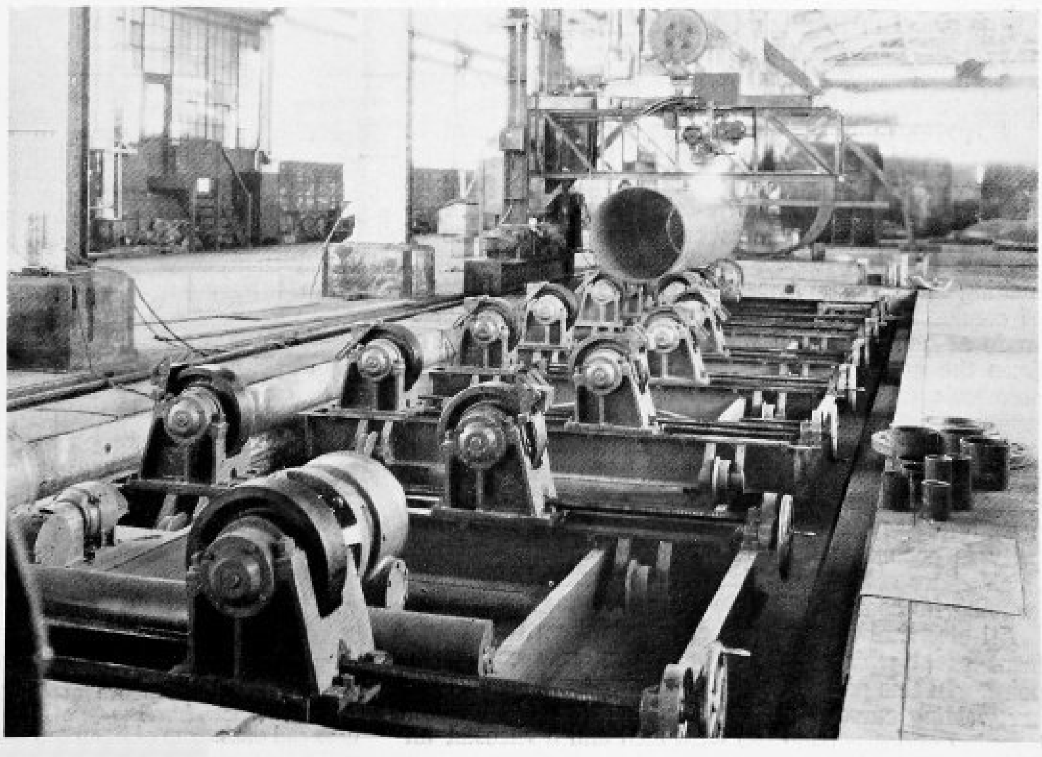
General view of shop, most modernly equipped for pressure vessel welding

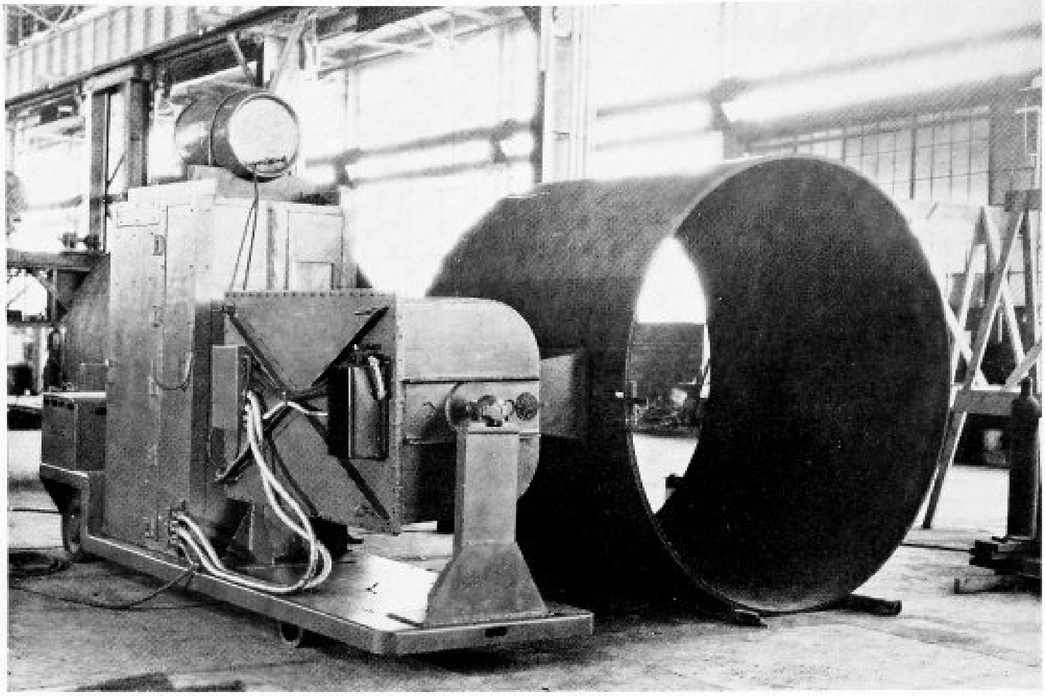
and practiced fully as long as direct current welding but its application has been very limited. The reason for this is that until heavily coated electrodes were generally available and the welding of unfired pressure vessels was officially sanctioned by the A. S. M. E. Code, the field in which alternating current shows up to best advantage was practically non-existent.

Metallurgically and physically it appears that a prerequisite to Class I welding is the use of heavily coated electrodes, sometimes known as the shielded-arc type. Shielded-arc electrodes form a gaseous envelope around the arc, excluding the detrimental elements, oxygen and nitrogen, of the atmosphere from contact with the molten metal as it passes through the arc. They also deposit a slag coating on top of the weld metal, further protecting it during solidification, as well as contributing somewhat of a grain refining function. In some cases the heavy coating of the rod includes alloying elements. With shielded-arc electrodes it is possible to obtain deposited weld metal equal, and often superior, in many of its properties to rolled plate parent stock.

There seems to be an inherent characteristic of the alternating-current arc which requires certain closely defined electrode characteristics. It has therefore been

One of the two automatic arc welding machines is shown on the opposite page and at the right. This machine will take vessels 2 to 14 feet in diameter and 70 feet long





Portable X-ray machine in position for examining longitudinal joint of a large pipe section

found that electrodes formerly satisfactory for direct current are not necessarily successful with alternating current. However, it is now known that properly designed alternating-current electrodes are likewise good when used with direct current.

In the field of welding covered by my subject, there is available a complete line of equipment for alternating current. A typical installation will be described later. Transformer welding units are commercially available in the following sizes:

Amp. Ratings (85 Deg. C.) 1 Hour	Continuous	Terminal Volts Operation	Terminal Volts Open Cir.	Current Range Max.	Current Range Min.
500	375	40	80/90/100	500	125
750	575	40	"	750	175
1000	750	40	"	1000	250

Primary: Single phase, 60, 50 or 25 cycles; 220, 440 or 550 volts. Auxiliary attachments are:

1. An extra attachment for reducing secondary open-circuit voltage to 50 percent of normal.
2. An extra attachment for low currents down to 10 percent of the one hour rating.

An automatic arc-welding head, to justify its name as such, is a motor-driven, wire-feeding device, with electrical control which causes automatic maintenance of the arc length irrespective of variations in electrode melting rate. Such devices also are provided with means of conducting the welding current to the metallic electrode at a point which remains at a constant distance from the arc at all times. It is always preferable in automatic welding to use the electrode in continuous lengths from a reel. Unless this is done, one of the important economies of this process is lost, namely, the saving of the loss of electrode material in short ends that cannot be consumed. With the proper combination of a well-designed electrode and automatic head, no difficulty is encountered in feeding any size and type of shielded-arc electrode which can be reeled without destroying its coating.

All electrical adjustments are made from the instrument panel which may be located at any convenient point. In this panel are mounted instruments for reading welding current and voltage, switches for starting, stopping and reversing the wire feed and a rheostat for adjusting the speed of wire feed. There are also provisions for other control items when used, such as a rheostat for adjusting travel carriage speed and switches for independently controlling this function.

Suitable electrodes for automatic alternating current welding of Class I pressure vessels have, beside the necessary arcing characteristics, a high gas producing coating and one which provides complete slag coverage for the weld. The slag is easily removed from the weld metal after it has cooled. It is, of course, understood that the resultant weld deposit meets the physical and X-ray requirements for Class I pressure vessels with the minimum expenditure of effort and time.

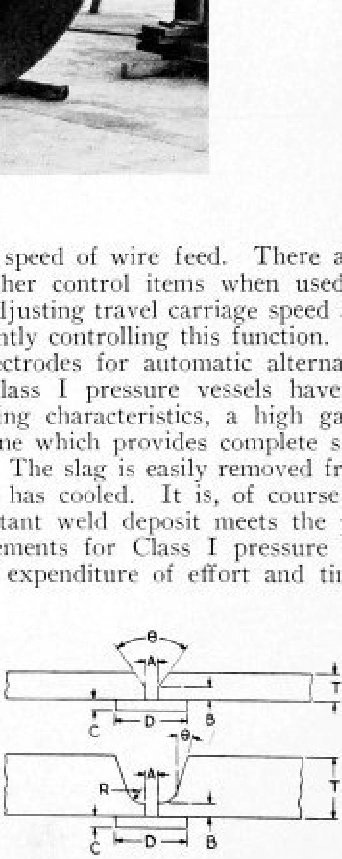


Plate Thickness T Inches	Edge Preparation Fig. No.	θ Degrees	A Inches	B Inches	C Inches	D Inches	R Inches	Number of Passes
1/4	8	70	1/8-5/32	1/8	1/8	1 1/4	—	3
3/8	8	70	1/8-5/32	1/8	1/8	1 1/4	—	4
1/2	8	70	1/8-5/32	1/8	1/8	1 1/4	—	6
5/8	9	70	1/8-5/32	1/8	1/8	1 1/4	—	7
3/4	9	7 to 9	1/8-5/32	1/8	1/8	1 1/4	5/16	8
7/8	9	7 to 9	1/8-5/32	1/8	1/8	1 1/4	5/16	9
1	9	7 to 9	1/8-5/32	1/8	1/8	1 1/4	5/16	12
1 1/8	9	7 to 9	1/8-5/32	1/8	1/8	1 1/4	5/16	13
1 1/4	9	7 to 9	1/8-5/32	1/8	1/8	1 1/4	5/16	15
1 3/8	9	7 to 9	1/8-5/32	1/8	1/8	1 1/4	5/16	16
1 1/2	9	7 to 9	1/8-5/32	1/8	1/8	1 1/4	5/16	16

Top sketch; bevel or groove for plate thickness up to and including 1/2 inch. Below, bevel or groove for heavier plate. Table giving type and dimensions of bevel and number of passes to be used

For use with this automatic arc-welding machine, heavily coated shielded-arc electrode is provided in several varieties, as required by the material and process involved. It is covered by a fabric coating heavily impregnated with fluxing ingredients. This securely adheres to the base wire, due to the properties of the ingredients used. A colored spiral tracer thread is used still further to prevent damage to the coating in handling, as well as a means of identifying the various types of rod.

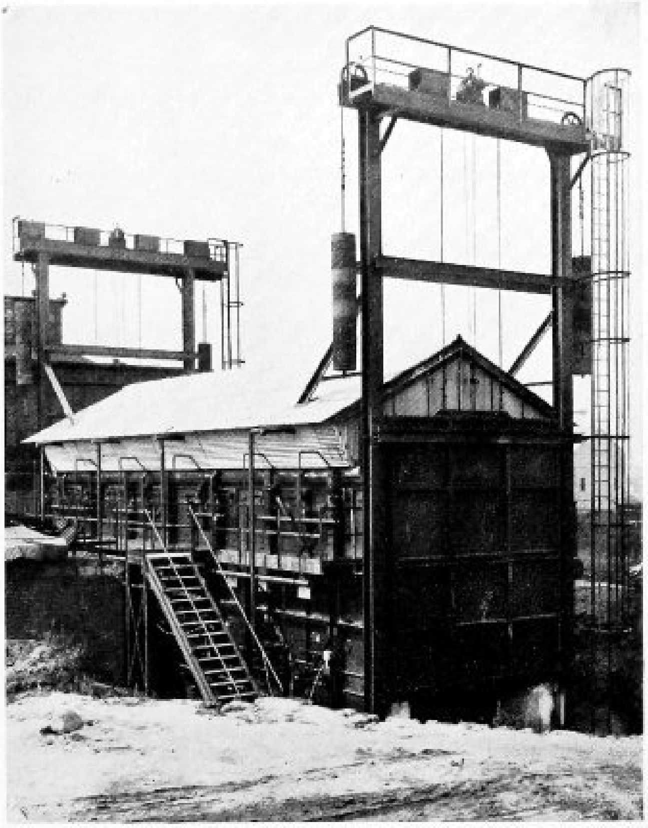
To apply the process and equipment I have described to Class I pressure vessels requires certain fixtures for holding the work in position and for traversing the arc across the work or *vice versa*, as well as material handling devices. These vary with the plant layout and are generally built to the particular specifications accompanying each individual installation. They are, however, all

Plate Thickness Inches	Description of Passes	Pass No.	Electrode Diameter Inches	Welding Current Amp.	Arc Voltage	Approx. Welding Speed Inches per Minute	Electrode Consumption Pounds per Minute	Oscillation	
								Approx. Amplitude Inches	Frequency Osc./min.
½"	Bottom of Groove	1	5/32	130	25	7½ to 8	.045	None	
		2	3/16	175	28	6	.074	None	
		3	3/16	175	28	5	.074	1/32	
		4	1/4	275	30	4¾	.13	1/16	
	Hand Backing Beads	5	1/4	275	30	4½	.13	1/16	
		6	1/4	275	30	4¼	.13	3/32	
1½"	Bottom of Groove	1	3/16	175	28	7½ to 8	.074	None	
		2	3/16	175	28	6	.074	None	
		3	1/4	380	38	5	.20	1/32	36
		4	1/4	380	38	4¾	.20	1/16	36
		5	1/4	380	38	4½	.20	3/32	36
		6	1/4	380	38	4¼	.20	1/8	36
		7	1/4	380	38	4	.20	5/32	36
		8	1/4	380	38	3½	.20	3/16	36
		9	1/4	380	38	3½	.20	7/32	36
		10	1/4	380	38	3½	.20	1/4	36
		11	1/4	380	38	3¼	.20	9/32	36
		12	1/4	380	38	3¼	.20	5/16	36
		13	1/4	380	38	3	.20	11/32	36
	Hand Backing Beads	14	1/4	380	38	3	.20	1/16	
		15	1/4	380	38	3	.20	3/32	
		16	1/4	320	38	3	.16	1/8	

Welding data for circumferential seams

based on the well-known principles of rolling devices for circumferential seams and travel carriages for longitudinal seams.

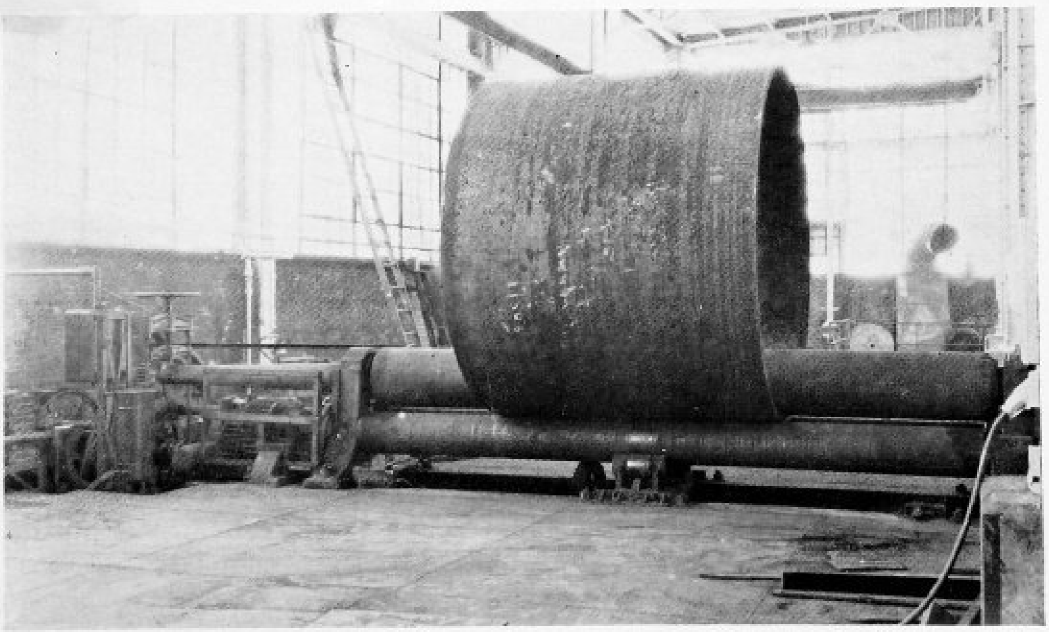
At its Carteret, N. J., plant the Foster-Wheeler Corporation now manufactures weld fabricated pressure



Exte.ior of gas-fired annealing furnace

vessels under the A. S. M. E. Code for Class I unfired pressure vessels. Alternating-current automatic arc welding is used exclusively for all seams excepting tank fittings, which are applied by hand welding with alternating current. This installation has been in successful production operation since the latter part of May, 1934, and had turned out approximately 225 tons of Class I vessels, up to September 1, 1934.

This concern has been actively engaged in weld fabrication for several years, but it is only recently that



For courses of large vessels and pipe sections the bending rolls are used for reforming to true circular shape after being welded they equipped themselves for Class I pressure vessel welding. The data given at this time are not intended as an impressive display of quantity production but are of particular interest as an example of high quality welding with alternating current successfully applied.

The shop is approximately 400 feet by 75 feet and equipped with seven bridge cranes for material handling. Three-phase, sixty-cycle primary power is purchased from the local power company, at 26,400 volts. A bank of six 150 kilovolt-ampere transformers step this down for the 220-volt, 3-phase, 60-cycle shop supply. Direct current for variable speed drives, such as the automatic welding machine, the travel carriage motors and the rolling device drives, can be furnished from a 220-kilowatt, 275-volt direct current generator, driven by a 260-horsepower synchronous motor. It is interesting to note that this welding shop is another instance of a foundry which has been converted into a weld fabricating shop, notwithstanding the fact that it was the most modern and one of the largest foundries in the Metropolitan district when placed in operation in April, 1924. This is a splendid example of modernization.

Most of the plate stock is purchased from the mill as required. This is common practice for such work. However, a small stock of light-gage plates is kept on hand at present in outdoor storage.

Often it is found desirable to have the plate edges machined at the mill, to the specified groove. All other stock can be planed on a standard type plate planer, 38 feet long which will handle at least 4-inch thickness without difficulty.

Shells from 33 inches minimum diameter up to the largest which can be shipped, 14 feet diameter, can be rolled on the 200-ton rolling equipment. An hydraulic pressure-brake takes care of the preliminary breaking of the plate edges.

The east end of the building is given over to these preliminary operations. Hand welding stations are located at convenient points in this section, for tack welding. Tack welding is done with 3/16-inch diameter electrode, using alternating current and approximately 150 amperes and 23 volts.

The shells are then taken to the automatic welding machine, located in the center of the building. This consists of the travel carriage assembly mounted on upper and lower supporting rails, with a length of travel of 70 feet. Alongside this track is a pit 65 feet in length, approximately 12 feet wide and 3 feet deep in which are four units for holding the vessel. Each alternate unit consists of a motor-driven rolling device and the other units are idling rollers. The motor-driven units are synchronized by control. For longitudinal seams the rolls remain stationary and the travel carriage moves along the seam, whereas for circumferential seams the travel carriage remains stationary and the shells are rolled under the arc. Each device is adjustable as to speed, from 2 to 15 inches per minute. Vessels from 2 feet to 14 feet diameter and up to 70 feet long can be handled on this equipment.

The welding procedure is as follows:

The bevel or groove is shown for plate thicknesses up to and including ½ inch and for all heavier plates in the illustrations on page 4. Experience has proved that the angle of V-bevel and of the sides of the U-groove are an important factor in obtaining successful results. Wider angles add nothing to quality and increase costs by requiring more weld metal deposits, which also reduces net welding speeds. Narrower angles tend to produce undercutting of the bottom layers of weld metal, thus entrapping slag and increasing the effort required in cleaning between passes and in repairing defects detected in the process of examination by the X-ray.

The first welding operation is the longitudinal seam. The tabulation on page 4 gives the plate thickness, type of bevel (U or V) and its dimensions and the number of layers or passes. The table on page 5 gives typical welding data and includes the electrode type and diameter per pass, the corresponding welding current, arc voltage, welding speed, wire consumption and oscillation amplitude and frequency. These data apply also to circumferential seams and are irrespective of vessel diameter or length.

The order of procedure is to weld the groove full, including reinforcement at the top, then chip off the backing-up strip and reweld the back of the groove by hand, filling in the weld metal that was removed in chipping off the backing-up strip, and reinforcing the weld on the back. Welding layers average ⅛-inch thickness and reinforcement extends above the plate surface the amount required by the boiler code. This reinforcement is chipped off on all fired pressure vessels or when the customer requires it to be done on other vessels.

Cleaning between passes is accomplished by loosening the slag with a hooked instrument much like a pinch-bar. The chips are blown out and the oxides and spatter are removed from the sides of the groove with a pneumatic tool. The weld is then cleaned again with a hand wire brush.

The welding transformer for the automatic arc is rated 750 amperes 1 hour or 575 amperes continuous, 40 volts secondary. Five hundred ampere transformers are used for hand welding.

After welding, the test plates are removed and all seams are marked with the usual lead identification markers, for X-ray examination. Every seam is examined with an X-ray machine equipped with a 300-000-volt tube. This machine is of the most modern type known and is mounted on a special electric truck for ready portability. Defects when found are chipped out, rewelded and X-rayed again. A permanent record is kept of every inch of welded seam. To date, this company has automatically welded and X-rayed 1400 linear feet of welded seams and has found 0.04 percent of defects, which have been completely eliminated before completion of the vessels. This remarkable record is particularly notable when it is known that the defective welds are considered to have all been due to imperfect plate edge preparation. This company states that when they have eliminated the defective grooving they expect practically to eliminate the small number of weld defects that are now being encountered.

The test plates are the first to be X-rayed. They are then removed and while the vessel itself is being examined these samples are stress-relieved in a small electric furnace under exactly the same conditions that will be applied to the entire vessel. These conditions are accurately controlled and recorded for duplication on the vessel. Physical tests are then made and the check tests of the seam are completed nearly as soon as the vessel is ready for the furnace. No case has yet been found where the physical tests fail to meet all the Code requirements.

The following average physical properties after stress-relieving at 1200 degrees F. have been obtained on A. S. M. E. S-1 Boiler Plate:

Ultimate tensile strength	65,000 lb. per sq. in.
Yield point	54,000 lb. per sq. in.
Elongation, 0.505 specimen	31 percent in 2 in.
Elongation, free-bend	52 percent
Specific gravity	7.825
Impact (Charpy)	33 ft.-lb.

After X-ray, the complete shell is placed in a butane gas-fired furnace which will accommodate vessels up to 14 feet diameter and 30 feet long. The butane storage tank is located outside the southwest end of the building. This tank is a Class 2 vessel, also welded with the equipment and process described. The furnace is located at the northwest end and just outside the welding shop. Strain-relief annealing consists of heating to 1200 degrees F. and maintaining this temperature for 1 hour per inch of maximum plate thickness, then cooling to 500 degrees F. in the furnace. The rate of increase and decrease in temperature is three hours to raise from room temperature to 1200 degrees F. and 5 hours to cool to 500 degrees F.

Hand welding of fittings is also done with alternating current. The work is positioned for this operation.

Experience of the Foster-Wheeler Corporation in pressure vessel manufacture is that the alternating current automatic gives somewhat greater net welding speeds than could be obtained with direct current, and fewer defects to be chipped out. On hand welding, except with low-current values, the operators like to handle the alternating current arc. These same men were originally trained on direct current and, without exception, express preference for alternating current because of the ease with which it may be handled.

Maintaining Water-Column Valves and Fittings

Perhaps the most important single operation in connection with the care of locomotives is the maintenance of water-glass and water-column valves and fittings in suitable condition to give reliable readings of boiler-water levels. Among other roads, the Atchison, Topeka &

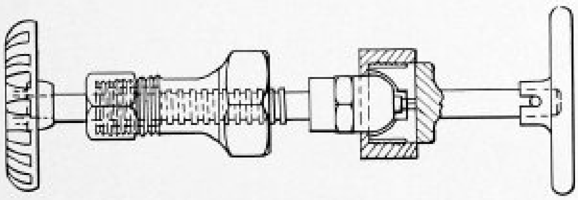


Fig. 1—Method of renewing the bearing on the drain-valve stem

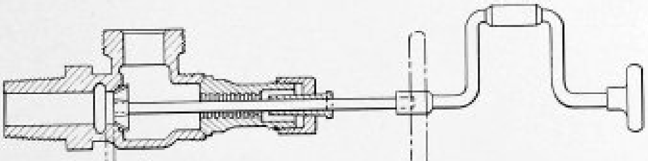


Fig. 2—Method of reseating the drain-valve body, using a special reseating tool

Santa Fe has given particular study to this subject and developed a standard practice for maintaining and cleaning these parts which, if followed, is sure to produce the desired results.

By this practice, drain valves on water glasses and water columns are thoroughly cleaned and reground at each monthly inspection, and oftener if necessary, to prevent leaks. If the seat in the valve or on the stem is cut and cannot be reground to a steam-tight joint, it is faced off with reseating tools, as shown in Figs. 1 and 2.

The reseating tool, shown in Fig. 1, is for use on ball surfaces on the end of the stem. The one shown in Fig. 2 is for use on the seat in the valve body. Just enough metal is removed from the ball on the stem or the seat in the valve to clean it up. When the seat in the valve has been trued up so that the dimension *A*, Fig. 2, is less than 1/16 inch, a new body is applied.

Fig. 3 shows the application of a modified bottom fitting which is standard on the Santa Fe. All bottom ends of water columns have the passage through the bottom vertical sleeve and the horizontal passage in the bottom

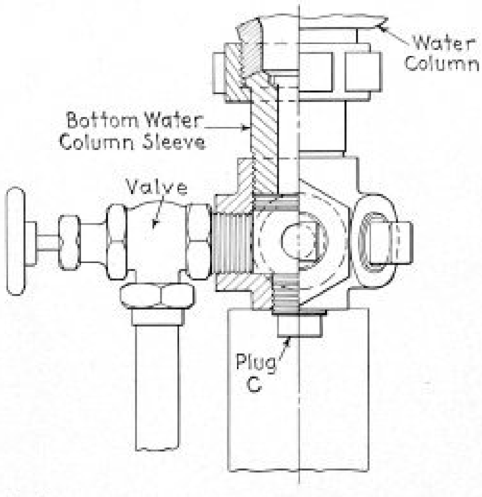


Fig. 3—Application of a modified bottom fitting to a water column

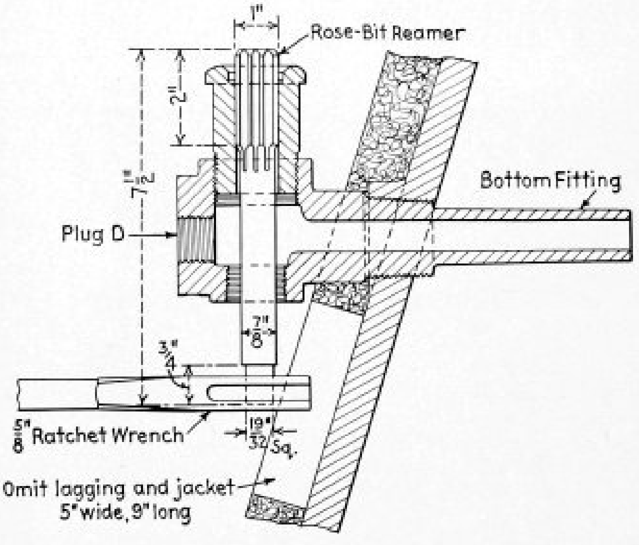


Fig. 4—Cleaning the vertical sleeve with a rose-bit reamer and small ratchet wrench

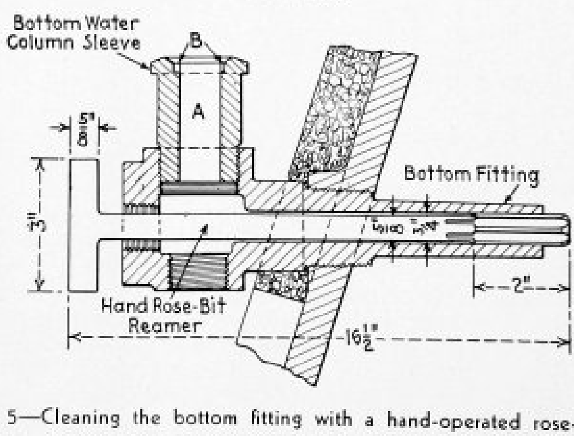


Fig. 5—Cleaning the bottom fitting with a hand-operated rose-bit reamer

fitting cleaned out each time the boiler is washed. These passages are cleaned by running a rose-bit through them, as shown in Figs. 4 and 5. Originally, the sleeve on the bottom of the water column was provided with lugs, which are now removed and slots *B* chipped as shown in Fig. 5.

In order to permit running a rose-bit through the passage in the bottom vertical sleeve, as shown in Fig. 4, the jacket and lagging below the bottom fitting is left off for a width of 5 inches and a length of 9 inches. At the time of cleaning out the bottom sleeve and fitting, plug *C*, Fig. 3, and plug *D*, Fig. 4, are removed to permit inserting the rose-bit reamer. When any flexible staybolt caps interfere with the operation of the rose-bit reamer, these bolts are removed and bolts with flush sleeve caps applied.

Code for Unfired Pressure Vessels*

The pressure-vessel problems of the petroleum industry, particularly in petroleum refining where relatively high pressures, high temperatures, and severe corrosion are frequently met, are such as to require special consideration. In order to provide a uniform basis for the construction and maintenance of unfired vessels used in this field, and at the same time not to disturb the uniformity brought about by the codes developed by the A.S.M.E. Boiler Code Committee, a joint committee of the American Petroleum Institute and The American Society of Mechanical Engineers was organized. This Joint A.P.I.-A.S.M.E. Committee on Unfired Pressure Vessels has now completed the first edition of the A.P.I.-A.S.M.E. Code for Unfired Pressure Vessels for Petroleum Liquids and Gases which can be obtained from The American Society of Mechanical Engineers, 29 West 39th Street, New York.

The code covers the design, construction, inspection and repair of unfired pressure vessels for petroleum liquids and gases for metal temperatures not over 1000 degrees F. and for gage pressures above 15 pounds per square inch. It is divided into five sections as follows:

W—Design and Construction of Fusion-Welded Vessels
R—Design and Construction of Riveted Vessels
F—Design and Construction of Seamless Forged Vessels (in course of preparation)
I—Inspection, Repair and Allowable Working Pressure of Vessels in Service
S—Material and Other Specifications.

A special feature of the Joint Code that merits emphasis is its inspection section and its requirement for changing operating conditions to keep stresses at or below those for which the vessel is designed or, as an alternative, removing the vessel from service. It is obvious, therefore, that the code should be used as a whole and that vessels constructed in accordance with the construction sections should be regularly inspected in accordance with the inspection section.

Attention should be called to the fact that the A.S.M.E. Boiler Code, Section VIII, dealing with unfired pressure vessels has been adopted as the law governing the construction of certain vessels of this type in several states, and that consequently vessels within the scope of this section for use in these states must be built in accordance with the Boiler Code rules. The Joint Code does not have such a legal status.

It is anticipated that many questions will arise with respect to the meaning of parts of the code, and also as to the scope of its application. These questions should be referred to the joint committee whose secretary is R. P. Anderson, 50 West 50th Street, New York. Suggestions for improvement will also be welcomed.

* Statement prepared by the Joint A.P.I.-A.S.M.E. Committee on Unfired Pressure Vessels to explain the relationship between the new joint A.P.I.-A.S.M.E. Code for Unfired Pressure Vessels and the A.S.M.E. Boiler Code.

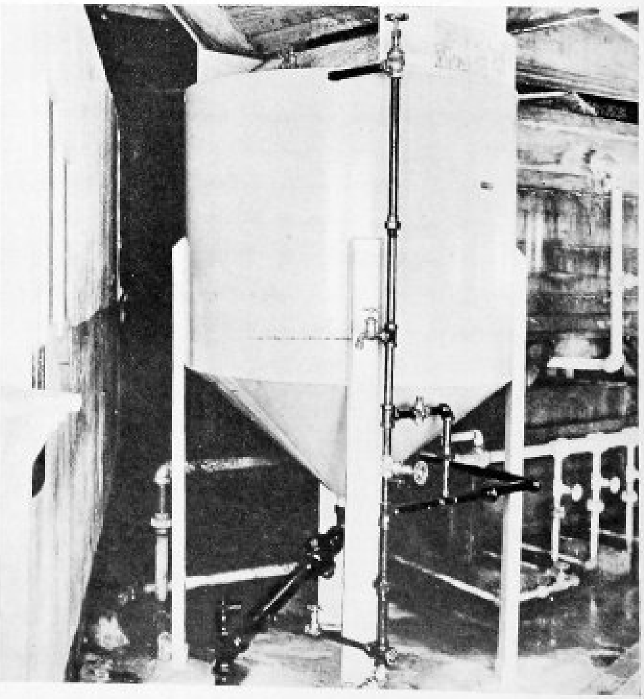
Assures Clean Brine Supply With Nickel-Clad Steel

Where brine solutions are employed in meat-curing, refrigeration, regenerating Zeolite water softeners or for processing purposes, the problem of dissolving rock salt without contamination of the brine is being solved through the use of rock salt dissolving equipment constructed of nickel-clad steel.

The illustration shows a nickel-clad steel rock salt dissolver, of welded construction, as supplied under lease by The International Salt Company of Scranton to users of its "Isco" rock salt. The top, shell, and conical bottom of the unit are nickel-clad steel throughout, with piping and fittings of monel metal. The unit is 48 inches in diameter and capable of producing 200 gallons of pure saturated brine per hour.

Nickel-clad steel is a joint development of The International Nickel Company and Lukens Steel Company and is produced at the latter's mills in Coatesville, Pa. It is a hot-rolled bi-metal composed of a light layer of pure, solid nickel permanently bonded to a heavy base of ordinary steel. The pure nickel surface of the bi-metal gives all the corrosion-resistance and other advantages of pure, solid nickel, while saving from one-third to one-half the cost which would be involved by construction with solid, corrosion-resistant metals.

In nickel-clad steel rock salt dissolvers, harmful corrosion or rust cannot occur because the brine comes in contact only with the pure nickel surface. Thus, the highest purity of brine is assured.



Nickel-Clad steel rock salt dissolver

Fig. 1—Result of a low water failure

Chief inspector reports year's

LOCOMOTIVE ACCIDENTS

In the twenty-third annual report of the Bureau of Locomotive Inspection to the Interstate Commerce Commission, compiled by Chief Inspector A. G. Pack, the work of the bureau during the fiscal year 1934 is set forth. The report follows in part:

Summaries are given, by railroads, of all accidents, showing the number of persons killed and injured due to the failure of parts and appurtenances of locomo-

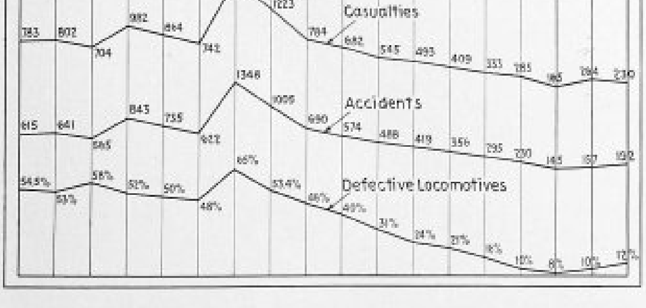


Fig. 2—Relation of defective locomotives and accidents resulting from failures

ACCIDENTS AND CASUALTIES CAUSED BY FAILURE OF SOME PART OR APPURTENANCE OF THE STEAM LOCOMOTIVE BOILER [1]

	1934	1933	1932	1931	1930	1929	1915	1912
Number of accidents........	63	53	43	91	105	119	424	856
Number of persons killed....	4	3	8	15	12	14	13	91
Number of persons injured...	77	55	46	122	113	133	467	1,005

[1] The original act applied only to the locomotive boiler.

REPORTS AND INSPECTIONS—STEAM LOCOMOTIVES

	1934	1933	1932	1931	1930	1929
Number of locomotives for which reports were filed.	54,283	56,971	59,110	60,841	61,947	63,562
Number inspected	89,716	87,658	96,924	101,224	100,794	96,465
Number found defective	10,713	8,388	7,724	10,277	16,300	20,185
Total number of defects found	43,271	32,733	27,832	36,968	60,292	77,268

CONDITION OF LOCOMOTIVES, FOUND BY INSPECTION, IN RELATION TO ACCIDENTS AND CASUALTIES

Fiscal year ended June 30	Percent of locomotives inspected found defective	Number of locomotives ordered out of service	Number of accidents	Number of persons killed	Number of persons injured
1923	65	7,075	1,348	72	1,560
1924	53	5,764	1,005	66	1,157
1925	46	3,637	690	20	764
1926	40	3,281	574	22	660
1927	31	2,539	488	28	517
1928	24	1,725	419	30	463
1929	21	1,490	356	19	390
1930	16	1,209	295	13	320
1931	10	688	230	16	269
1932	8	527	145	9	156
1933	10	544	157	8	256
1934	12	754	192	7	223

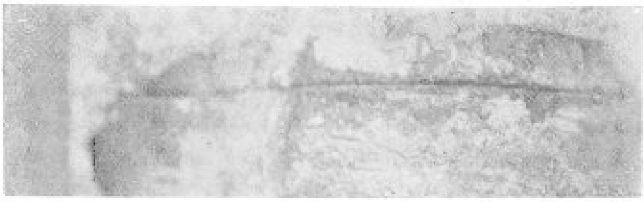


Fig. 3—Longitudinal crack in boiler barrel

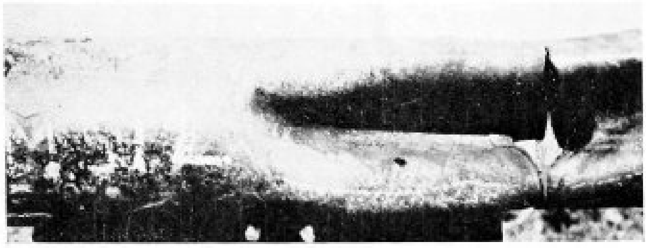


Fig. 4—Collapsed superheater flue

Number of Steam Locomotives Reported, Inspected, Found Defective, and Ordered from Service

Parts defective, inoperative or missing, or in violation of rules	Year ended June 30— 1934	1933	1932	1931	1930	1929
1. Air compressors.....	660	474	417	481	873	1,202
2. Arch tubes..........	127	51	54	60	87	104
3. Ash pans and mechanism	87	40	69	81	76	132
4. Axles	6	21	13	10	12	20
5. Blow-off cocks........	289	210	144	191	325	442
6. Boiler checks........	407	293	214	263	521	761
7. Boiler shell..........	372	296	220	430	579	841
8. Brake equipment.....	2,326	1,696	1,645	1,923	2,706	3,894
9. Cabs, cab windows, and curtains	1,342	1,183	851	1,484	3,066	2,140
10. Cab aprons and decks.	343	309	262	415	710	1,005
11. Cab cards	129	121	162	211	226	305
12. Coupling and uncoupling devices........	54	67	85	98	122	154
13. Crossheads, guides, pistons, and piston rods	1,100	773	763	856	1,421	1,887
14. Crown bolts..........	77	67	50	96	95	129
15. Cylinders, saddles, and steam chests.......	1,491	1,084	841	1,265	2,311	3,210
16. Cylinder cocks and rigging	654	374	376	411	848	967
17. Domes and dome caps	105	76	45	83	154	227
18. Draft gear..........	401	318	325	568	950	1,310
19. Draw gear...........	480	357	371	640	1,003	1,367
20. Driving boxes, shoes, wedges, pedestals and braces	1,472	1,080	821	925	1,359	1,993
21. Fire-box sheets.......	356	246	235	341	471	657
22. Flues	203	150	120	187	254	334
23. Frames, tailpieces, and braces, locomotive..	951	669	611	740	1,271	1,377
24. Frames, tender.......	128	80	86	105	177	297
25. Gages and gage fittings, air..........	212	145	156	192	290	309
26. Gages and gage fittings, steam........	289	258	214	324	553	678
27. Gage cocks..........	384	388	330	415	783	1,114
28. Grate shakers and fire doors	404	245	288	410	767	295
29. Handholds	377	363	382	562	865	1,125
30. Injectors, inoperative.	33	20	31	55	103	86
31. Injectors and connections	1,909	1,357	1,168	1,815	3,275	4,484
32. Inspections and tests not made as required	8,173	6,358	3,801	4,862	7,456	9,246
33. Lateral motion.......	351	269	237	289	372	618
34. Lights, cab and classification	79	76	55	77	119	121
35. Lights, headlights....	218	169	119	180	373	488
36. Lubricators and shields	215	157	119	176	312	423
37. Mud rings...........	247	232	166	318	445	636
38. Packing nuts.........	491	419	402	523	828	991
39. Packing, piston rod and valve stem....	833	592	444	706	1,429	1,708
40. Pilots and pilot beams	174	123	145	160	272	371
41. Plugs and studs......	242	151	176	182	348	482
42. Reversing gear.......	390	254	202	299	579	788
43. Rods, main and side, crank pins, & collars.	1,670	1,327	1,256	1,520	2,488	3,465
44. Safety valves........	108	53	63	61	116	170
45. Sanders	697	376	289	314	804	1,008
46. Springs and spring rigging	2,854	2,122	1,851	2,161	3,311	4,557
47. Squirt hose..........	107	93	96	184	313	387
48. Stay bolts...........	285	219	181	293	395	542
49. Stay bolts, broken....	455	368	552	938	1,098	1,197
50. Steam pipes..........	489	338	285	512	730	925
51. Steam valves.........	267	193	143	226	399	471
52. Steps	567	498	622	676	1,021	1,394
53. Tanks and tank valves	862	600	587	732	1,426	1,717
54. Telltale holes.........	93	90	108	151	183	174
55. Throttles and throttle rigging	639	448	434	574	1,175	1,554
56. Trucks, engine and trailing	898	664	648	714	1,141	1,605
57. Trucks, tender.......	918	747	766	1,059	1,531	2,144
58. Valve motion........	784	640	520	497	827	1,067
59. Washout plugs.......	776	623	599	815	1,283	1,871
60. Train-control equipment	8	4	13	9	48	60
61. Water glasses, fittings, and shields.........	907	716	676	955	1,501	1,816
62. Wheels	734	580	603	750	1,025	1,325
63. Miscellaneous — signal appliances, badge plates, brakes (hand)	572	423	325	418	691	1,101
Total number of defects	43,271	32,733	27,832	36,968	60,292	77,268
Locomotives reported.....	54,283	56,971	59,110	60,841	61,947	63,562
Locomotives inspected....	89,716	87,658	96,924	101,224	100,794	96,465
Locomotives defective....	10,713	8,388	7,724	10,277	16,300	20,185
Percentage of inspected found defective.......	12	10	8	10	16	21
Locomotives ordered out of service	754	544	527	688	1,200	1,490

tives, as reported and investigated under section 8 of the locomotive inspection law, and those reported to the Bureau of Statistics under the accident report act of May, 1910, and not reported to the bureau in accordance with the requirements.

The tables showing the number of accidents, the number of persons killed, and number injured have been arranged to permit comparison with previous years as far as consistent. These tables also show the number of locomotives inspected, the number and percentage of those inspected and found defective, the number for which written notices for repairs were issued in accordance with section 6 of the law, and the total defects found and reported.

Summaries and tables show separately accidents and other data in connection with steam locomotives and tenders and their appurtenances and accidents and other data in connection with locomotives other than steam.

A summary of all accidents and casualties to persons occurring in connection with steam locomotives compared with the previous year shows an increase of 22.3 percent in the number of accidents, a decrease of 12.5 percent in the number of persons killed, and a decrease of 12.9 percent in the number of persons injured.

The increase in accidents and casualties brought about by increase in defective locomotives, and the converse, are illustrated graphically by the chart Fig. 2.

Another table shows the various parts and appurtenances of steam locomotives and tenders which through failure have caused serious and fatal accidents. If the information contained in this table is taken advantage of and proper inspections and repairs made in accordance with the requirements of the law and rules many accidents will be avoided.

During the year 12 percent of the steam locomotives inspected by our inspectors were found with defects or errors in inspection that should have been corrected before the locomotives were put into use as compared with 10 percent in the previous year and 8 percent in the year ended June 30, 1932. The increase in the percentage of locomotives found defective was brought about by the action of the railroads in drastically curtailing their maintenance forces over the period affected and, in general, performing only such work as appeared to them to be immediately necessary for the time being. The effect of this policy was to produce a considerably greater recession in the condition of locomotives over the 2-year period, and especially for the year just passed, than is indicated by the increase in the percentage found defective because of the accumulated wear of major parts which would otherwise have been restored currently. There was an increase of 38.6 percent in the number of locomotives ordered withheld from service by our inspectors because of the presence of defects that rendered the locomotives immediately unsafe as compared with the previous year, an increase of 31.3 percent in the total number of defects found, and increases in individual items found defective ranging from 3 percent to 149 percent. A comparison of the number of defects found over a 6-year period is shown in the table, page 10, from which it will be noted that the increase in the number of defects is represented largely by items that require the application of heavy repairs to restore the deferred maintenance.

Boiler explosions or crown-sheet failures continue to be the most prolific source of fatal accidents. There was an increase of 2 accidents, an increase of 2 in the number of persons killed, and an increase of 15 in the number of persons injured from this cause, as compared with the previous year. There was, however, compared with the fiscal year ended June 30, 1912, the first year the Boiler Inspection Act was operative, a reduction of 92.6 percent in the number of accidents, a reduction of 94.8 percent in the number of persons killed, and a reduction of 89.9 percent in the number of persons injured.

One thousand six hundred and seventy-four applications were filed for extensions of time for removal of flues, as provided in rule 10. Our investigations disclosed that in 140 of these cases the condition of the locomotives was such that extensions could not properly be granted. One hundred and sixty-five were in such condition that the full extensions requested could not be authorized, but extensions for shorter periods of time were allowed. One hundred and eighty-nine extensions were granted after defects disclosed by our investigations were required to be repaired. Fifty applications were canceled for various reasons. One thousand one hundred and thirty applications were granted for the full periods requested.

Under rule 54 of the Rules and Instructions for Inspection and Testing of Steam Locomotives, 120 specification cards and 3655 alteration reports were filed, checked, and analyzed. These reports are necessary in order to determine whether or not the boilers represented were so constructed or repaired as to render safe and proper service and whether the stresses were within the allowed limits. Corrective measures were taken with respect to numerous discrepancies found.

Under rules 328 and 329 of the Rules and Instructions for Inspection and Testing of Locomotives Other Than Steam, 37 specifications and 8 alteration reports were filed for locomotive units and 3 specifications and 25 alteration reports were filed for boilers mounted on locomotives other than steam. These were checked and analyzed and corrective measures taken with respect to discrepancies found.

No formal appeal by any carrier was taken from the decisions of any inspector during the year.

Typical Boiler Failures

Fig. 1 shows the result of a crown-sheet failure caused by overheating due to low water; this accident caused the death of 3 employees and the serious injury of 3 employees and 7 non-employees. The locomotive was hauling a passenger train and the explosion occurred about 500 feet from the point where the train would normally have stopped in a passenger station.

The force of the explosion tore the boiler from the frame and hurled it upward and forward. The boiler crashed through the superstructure of an overhead con-

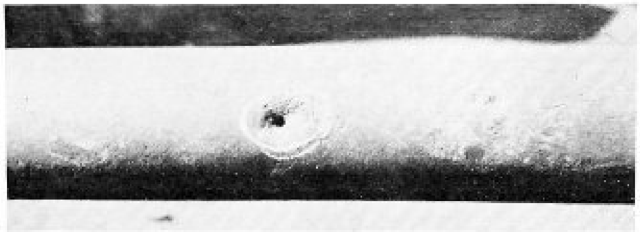


Fig. 5—Pitted superheater flue

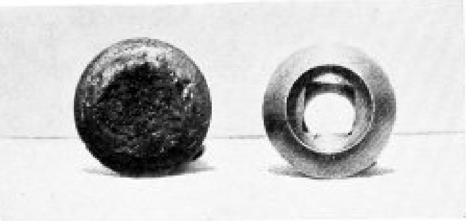


Fig. 6—Water column fitting plugged solid, compared with fitting in proper condition

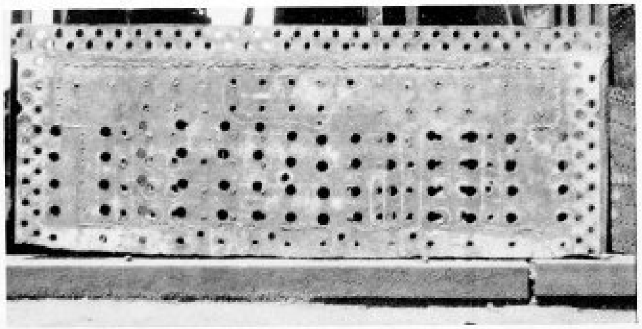


Fig. 7—Example of defective roof sheet repairs

course and came to rest 179 feet forward and 25 feet to the left of the point where the failure occurred.

The running gear of the locomotive remained attached to the train and came to a stop about 25 feet from the point of accident.

Fig. 3 shows a longitudinal crack in the barrel of a boiler. The condition was known by the carrier's officials at two engine houses from which the locomotive was dispatched prior to being found and ordered withheld from service by our inspector.

Fig. 4 shows a superheater flue that collapsed and pulled apart at a fusion weld joining the body flue and safe end. The escaping hot water and steam caused the serious injury of two employees.

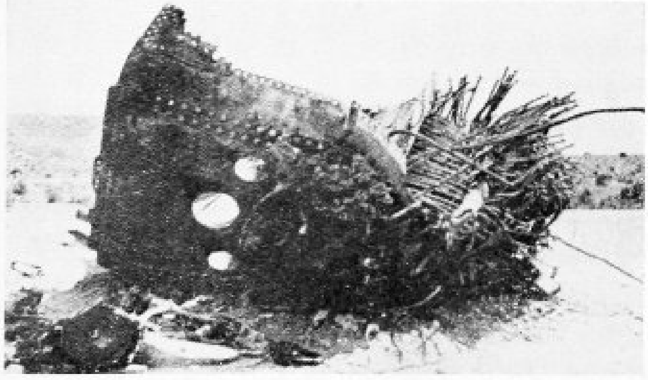
Fig. 5 shows a thinned and pitted superheater flue found by our inspector in the boiler of a locomotive that had just been turned out of the shop after all flues had been reset. The locomotive was ordered withheld from service after which other superheater flues in the boiler were found in similar condition. The hole shown in the flue was made by a light blow with a testing hammer.

Fig. 6 shows a vertical sleeve joining the bottom of a water column and the boiler fitting stopped practically solid with scale compared with a similar fitting on the right which does not contain any deposit. The stopped-up sleeve was found by our inspector on a locomotive that he ordered withheld from service when it was found that there was little or no movement of the water in the water glass when attempt was made to blow out the column and water glass. Defective and improper water level indicating appliances have been the cause of many overheated crown sheets and much damage to property and serious injury and loss of life to persons. Extreme care should be exercised to see that these appliances are maintained in good condition at all times. Water columns and connections should be blown out and tested before each trip, and parts where scale or sediment is liable to accumulate should be thoroughly cleaned each time gage cocks and water-glass cocks are required to be cleaned.

Fig. 7 shows the front part of the roof sheet of a boiler that was undergoing extensive repairs when examined by our inspector at which time practically all contemplated repairs had been applied, except application of the flues and staybolts. The front end of the crown sheet had been supported by three transverse rows of sling stays attached at the upper ends to T-bars extending across the roof sheet and riveted thereto. The T-bars and sling stays had been removed in preparation for the application of expansion stays of the flexible staybolt type in lieu of the sling stays, the rivet holes in the sheet had been filled in with fusion welding, and a patch welded on the inside as indicated by the line of welding extending around the circumference of the sheet. Holes for fitting the expansion stay sleeves had been cut through both sheets with a cutting torch, badly mutilating the sheets. The holes were cut too large for the sleeves and it was the intention to fill in with fusion welding to form supports for the sleeves. Our inspector required that the damaged part of the sheet be removed. Practically all of the fusion welding that had been applied to fill in the rivet holes fell out when the sheet was straightened to use as a template for the new sheet.

Freight Locomotive Explosion Fatal to Three*

The explosion of a large freight locomotive operated by the Denver and Rio Grande Western Railroad, near



Part of locomotive's crown sheet and left wrapper sheet

Price, Utah, on August 18, 1934, caused the death of three trainmen, and resulted in the derailment of eight cars and damage to freight and livestock.

The men who were killed were the engineer, the fireman and the brakeman. There were between 65 and 70 transients on the 61 cars that made up the train, but none of them was injured.

The entire rear of the locomotive was blown away and the barrel of the boiler was hurled 1200 feet. The running gear traveled some distance on the tracks before it derailed and overturned, tearing up tracks for a distance of between 500 and 600 feet, and causing an interruption of passenger service on the line.

The engine had been climbing a 2 percent grade from Greenriver, Wyoming, and had traveled about 200 feet on the level track when the explosion occurred.

A complete detailed report of this accident from the Bureau of Locomotive Inspection will be published in an early issue.

* From *The Locomotive*.

Work of the A.S.M.E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published.

Below are interpretations of cases Nos. 776, and 786 to 793 inclusive.

Case No. 776 (*Annulled*)

Case No. 786 (*Interpretation of Specifications S-27*)

Inquiry: Is it permissible under the Code to make forged shells from steel complying with Specifications S-27, Grade B, instead of Specifications S-4, Class 2?

Reply: It is the opinion of the Committee that it is permissible to make this substitution provided the number of test specimens, the number of tests and the method of taking the test specimens, and the bend tests comply with Specifications S-4. The chemical and other physical requirements should comply with Specifications S-27.

Case No. 787 (*Interpretation of Par. P-186*)

Inquiry: The reply in case No. 253 discourages the practice of welding short lengths of tubes together to make a usable length. The latest wording of Par. P-186 very definitely authorizes the practice of welding parts of boilers by electric-resistance butt welding. Should not this feature of Case No. 253 be annulled and will the Committee formally sanction lengthening tubes by welding two or more sections together under the provisions of Par. P-186?

Reply: In the opinion of the Committee it is permissible to join two or more sections of tubes by the methods prescribed in Par. P-186, and accordingly, that portion of Case No. 253 which conflicts therewith is hereby annulled.

Case No. 788 (*Interpretation of Par. P-260*)

Inquiry: Par. P-260 of the Code requires manhole frames on shells or drums to be attached by riveting. Other paragraphs of the Code permit the welding on of boiler parts in various ways and for various purposes. Should not Par. P-260 have been revised to provide for welded construction? Would it not be within the present intent of the Code to attach manhole frames by welding?

Reply: The requirements of Par. P-260 should have been extended to include the attachment of manhole frames by welding. It is the opinion of the Committee that if the requirements of Pars. P-101 to P-111 and P-268, omitting X-raying, are complied with, the intent of the Code will be met.

Case No. 789 (*In the hands of the Committee*)

Case No. 790 (*In the hands of the Committee*)

Case No. 791 (*Interpretation of Par. P-299*)

Inquiry: Par. P-299 of the Code requires that valves and fittings on water lines below the water line shall be equal at least to the requirements of the American Standards for a pressure 25 percent in excess of the maximum allowable working pressure. This would apparently limit the use of the present 250-pound standard valves and fittings to 200-pound maximum allowable working pressure and also require a valve with a pressure rating of 313 pounds to be used for 250-pound maximum allowable working pressure. Since there are no tables giving flange and body thicknesses for cast iron valves and fittings over 250-pound pressure, will it be permissible to increase the flange and body thicknesses to permit the use of cast iron valves and fittings on water lines below the water line, up through 250-pound maximum allowable working pressure?

Reply: It is the opinion of the Committee that the present 250-pound cast iron flange and fitting standards should not be used for the purpose described for maximum allowable working pressures exceeding 200 pounds per square inch. It is permissible to increase the flange and body thicknesses as described, maintaining the same deflection limits and to give at least the same factor of safety as for fittings specified in the 250-pound standard and use these valves and fittings up to 250-pound maximum allowable working pressure. The Committee recommends, however, that for the service stated, cast iron valves or fittings be not used for pressures over 200 pounds per square inch.

Case No. 792 (*Special Case*)

Inquiry: In the fabrication of A.S.M.E. Code unfired pressure vessels, is it permissible to construct forged seamless vessels, to be used at temperatures not to exceed 700 degrees F., of annealed austenitic chrome-nickel steel in accordance with specifications submitted (on file in Secretary's office) which have the following chemical and physical requirements:

Chromium, min., percent	18.0
Nickel, min., percent	8.5
Carbon, max., percent	0.08
Manganese, percent	0.20–0.70
Phosphorus, max., percent	0.03
Sulphur, max., percent	0.04
Silicon, max., percent	0.70
Copper, max., percent	0.50
Tensile strength, min., lb. per sq. in.	80,000
Yield point, min., lb. per sq. in.	35,000
Elongation in 2 in., min., percent	35
Reduction of area, min., percent	50

Reply: Pending the results of joint action of the Boiler Code Committee and the American Society for Testing Materials upon proposed specifications for the steel in question, it is the opinion of the Committee that forged seamless unfired pressure vessels may be constructed under the provisions of the Code provided the maximum unit working stress, at temperatures not to exceed 700 degrees F., is 16,000 pounds per square inch.

Case No. 793 (*Special Case*)

Inquiry: In the fabrication of A.S.M.E. Code unfired pressure vessels, is it permissible to construct forged seamless vessels, to be used at temperatures not to exceed 450 degrees F., of copper nickel alloy in accordance with specifications submitted (on file in Secretary's office) which have the following chemical and physical requirements:

Copper, min., percent	23.0
Nickel, min., percent	60.0
Iron, max., percent	3.5
Aluminum, max., percent	0.5
Manganese, max., percent	3.5
Carbon, max., percent	0.3
Silicon, max., percent	0.5
Forgings	
Tensile strength, min., lb. per sq. in.	80,000
Yield point, min., lb. per sq. in.	60,000
Elongation in 2 in., min., percent	30
Reduction of area, min., percent	40
Rolled Plate	
Tensile strength, min., lb. per sq. in.	60,000
Yield point, min., lb. per sq. in.	25,000
Elongation in 2 in., min., percent	25
Reduction of area, min., percent	40

Reply: Pending the results of joint action of the Boiler Code Committee and the American Society for Testing Materials upon proposed specifications for the material in question, it is the opinion of the Committee that forged seamless unfired pressure vessels may be constructed under the provisions of the Code provided the maximum unit working stress, at temperatures not to exceed 150 degrees F., is 12,000 pounds per square inch.

Hercules Introduces Another Shockless Nut Runner

Early in the year The Buckeye Portable Tool Company, Dayton, O., manufacturer of Hercules portable pneumatic and high frequency electric tools, announced a new shockless nut runner, which derived its name from

Hercules shockless nut runner

its method of running a nut on its thread and bringing it up tight without shock to the operator. This shockless feature centers in a clutch which is arranged with an adjustable releasing cam to trip the clutch open when the nut is brought down tight. The operation does not depend on friction in the drive, so that when the cam operates the tool runs free.

This first model proved so popular that the demand for it in other sizes made necessary the introduction of a new model, No. 40-N, with a speed of 750 revolutions per minute and a capacity for ⅜-inch and light ½-inch nuts. This tool is similar in construction to the No. 30-N formerly introduced, and weighs 16½ pounds net and is 14½ inches overall length.

Explosions of Compressed Air Receivers*

Within the last few months two explosions of receivers containing compressed air occurred at two different works in the same town, and they demonstrate in no uncertain manner that the hazard of explosions from this type of pressure vessel is a real one, and should be guarded against by taking all possible precautions.

The first explosion was from a vertical air receiver of riveted construction, 5 feet in diameter and about 10 feet high, the upper end plate being outwardly dished and the lower end plate inwardly dished.

The compressed air was supplied by two air compressors, one of which was steam-driven and the other belt-driven. The former compressor had an automatic valve in connection with the air receiver which operated the throttle valve of the steam cylinder when the air pressure exceeded 80 pounds per square inch. The belt-driven compressor was provided with an automatic valve operating the suction valves on the compressor. In addition to these two cut-out devices, the air receiver was fitted with a safety valve.

Without previous warning, the receiver, with the exception of the bottom end plate, shot through the roof of the building, in which it was housed, to a height of about 100 feet, and in its flight came in contact with some obstruction which damaged the shell.

The bottom end plate was found embedded in the ground with its original inward camber reversed and the rivets which secured the end of the cylindrical shell torn away. Considerable damage was done to surrounding property but there was no serious injury.

It is reported that the cylindrical shell and end plates appeared to be free from wasting to any serious extent, and that only a slight trace of oil could be seen on the bottom end plate, while the cylindrical shell was quite clean. Owing to the bottom inwardly dished end plate being blown out, it is unfortunate that the exact (original) curvature of the plate could not be determined. From the information available however, it is evident that the dished end had a very large radius as compared with the diameter of the vessel, and on account of this formation it is probable that failure was due to bulging at the normal working pressure.

Inwardly dished ends require careful consideration in design in order to insure that they will not bulge when subjected to the working pressure. The determination of the safe working pressure primarily depends upon the following:

1. Radius of curvature of end plate.
2. Thickness of end plate.
3. The ratio of radius of curvature and the thickness of end plate.
4. Radius of knuckle at the flange connecting the end to the cylindrical shell.
5. Tensile strength of the material.

* From *Vulcan*, Journal of the Vulcan Boiler & General Insurance Company, Ltd., Manchester, England.

Each of the above should be taken into consideration when assessing the safe working pressure. Many inwardly dished ends have bulged and failed through a lack of a proper understanding of the conditions which affect their strength and resistance to bulging and collapse.

The second explosion, which occurred in the same town four weeks after that just described, was from a vertical air receiver of riveted construction, 3 feet 6 inches in diameter and 8 feet high, with the upper end plate outwardly dished and the lower end plate inwardly dished.

The compressed air was supplied by a steam-driven air compressor. The compressor was not provided with an automatic valve, but there was a safety valve which lifted at 100 pounds per square inch attached to the air receiver. This safety valve was stated to be in satisfactory and free working condition, and frequently lifted at a pressure of 100 pounds per square inch.

At the time of the explosion the air compressor was charging the receiver and compressed air was being withdrawn from the latter. As a consequence of the explosion the bottom end plate collapsed, and its original inward curvature was bulged to outward curvature, and 64 of the 72 rivets failed in the circular seam. The rivet heads on the outer side of the shell left the rivet shanks. As a result of the explosion, damage was done to the wall and roof in which the compressor was housed and to adjacent property.

As far as could be seen there was no wasting of any extent in the air receiver, either internally or externally, but an appreciable amount of grease deposit was found inside the receiver. The end plate which failed appears to have been of sufficient strength for withstanding the normal working pressure, and it is probable that excessive pressure was produced by an explosive mixture resulting from ignition of oil fumes.

Another explosion damaged an air receiver of somewhat less dimensions than the two cases previously described. In this case the receiver was 2 feet 6 inches in diameter and 6 feet high, and the joints were riveted throughout. The bottom end was provided with an inwardly dished end plate, and the normal working pressure varied from 75 pounds to 100 pounds per square inch. Shortly before the explosion, which occurred without warning, the pressure gage indicated 75 pounds per square inch. As a result of the explosion, the bottom end of the vessel was blown clean out, while the vessel itself was projected upwards and fell some distance away.

Upon examination it was found that the camber of the blown-out end had been reversed, showing that the pressure had been excessive. The rivets and part of the flange were also torn away.

From a consideration of the circumstances there can be little doubt that this explosion was due to the sudden ignition of gases given off by an accumulation of grease which had collected in the receiver. It may be mentioned that after the explosion the receiver was found to be coated with grease to a thickness of at least $\frac{1}{16}$ inch.

Accumulation of grease and carbonaceous dust is not an infrequent cause of air receiver explosions, the grease being derived from the lubricant used in the air compressor. Deposits of this kind under the influence of the heat due to air compression are liable to undergo a process of spontaneous combustion and the gases generated combining with the compressed air eventually ignite, causing a sudden and intense pressure which the vessel is quite incapable of resisting as in the case under review.

Brewery industry creates demand for

COATED STEEL TANKS

By H. A. Bradt

The legalizing of beer in this country after years of prohibition brought about a heavy demand for new tanks to do their part toward rehabilitating old breweries and equipping new ones; tanks which are necessary for the process of fermentation and for the aging and storing of the millions of gallons of beer consumed annually by the American public. The demand continues as expansion goes on and as new breweries are started, and the trend toward coated steel tanks brought about by the first feverish period of activity, when enough tanks of any kind were hard to obtain, has become definitely a factor in the choice of equipment.

There are several major reasons for this change in an old industry, where for years wood was standard equipment and, of course, one of them is the natural advantages possessed by steel, which allow it to be formed into nicely rounded shapes combined with strength and low cost. But back of that are the years of work done by the manufacturers of glass-lined steel tanks to establish their product successfully alongside of the wooden tank, and probably an equal amount of work done by one or two manufacturers of enamel-like coating material to prove the merits of their product which allows steel to be used at lower prices.

The steel industry as a whole, and especially that part of it benefitting directly from the manufacture of coated steel brewery tanks, cannot give too much credit to these people, for, while they may have been and still are working apart as far as individual interests are concerned, they have certainly made possible the opportunity presented to the plate fabricator to fill his shop at a time when orders were at a low ebb.

No attempt is being made here to compare the relative merits of glass-lined brewery equipment with that coated with the more plastic and more easily applied preparations; however, it must be acknowledged that the extensive plant and experience required for the former limits the source of supply, whereas many plants in all parts of the country regularly engaged in the processing of steel plate work are capable of turning out the latter. Naturally, many of these plants want brewery work and go after it, which increases the sales effort applied to get steel into the breweries and also keeps prices down, due to competition. The disadvantages of such a system show up occasionally when one of these shops turns out equipment not suitable for the service, due to lack of complete knowledge of what is necessary, which is the same as saying, a lack of experience, or, to an attempt to get by with the cheapest construction possible. When that occurs the damage is not confined to that individual case alone. It furnishes ammunition to the manufacturers using competitive materials, such as wood, concrete, etc., and the condemnatory word-of-mouth criticism of one brewery worker to another spreads far.

There is definite responsibility attached to any fabricator undertaking a brewery tank job, particularly when he is not supplied with complete specifications and drawings by a competent engineer or architect, and it is with the idea of calling attention to the many points to be considered when undertaking such a job that the following general specifications are given.

Material. The material should be open hearth steel with a tensile strength of 55,000 pounds per square inch. Tank quality is satisfactory for shell plates and for rectangular tanks, and pressing quality is suitable for dished heads.

Shell. The minimum thickness of shell plates should be ¼ inch even on the smaller tanks and some fabricators use $\frac{5}{16}$ inch on 10-foot diameter and ⅜ inch on 11-foot diameter tanks, although successful installations have been made using ¼ inch on 11-foot and even larger tanks, where they are to be used for storage only and where proper attention is given to supporting them.

Heads. The minimum thickness of heads should be $\frac{5}{16}$ inch up to 10-foot diameter and ⅜ inch for 10-foot and over. Shallow dished heads are generally satisfactory for the pressures used in brewery work and have been used for a working pressure of 22 pounds per square inch; however, the deflection on a 10-foot diameter by a ⅜-inch shallow dished head under 30 pounds pressure is about 1½ inches. Heads should always be flanged and the knuckle radius should not be less than 1½ inches. Sharp corners are to be avoided.

Joints. All seams should be double welded butt and should be made by means of the shielded-arc process. The edges of plates at joints should not be offset from each other at any point and where plates of different thicknesses join, such as the head to the shell, the inside surfaces should be flush. Particular care should be taken to prevent undercutting of the inside weld and all joints should be chipped and ground flush on the inside. The tank should have a strictly smooth interior; wherever a lap joint is used or any uneven surface is left on the inside, the coating will be worn through in the cleaning process. Where two plates are joined at or near a right angle without a good corner radius, the coating will be worn and chipped from the action of the back of the brush in contact with the coating during the attempt to clean the corner thoroughly.

Fittings. The proper openings are determined in some cases by the procedure in the brewery in which the tanks are to be placed but in general, they are fairly standard; the important thing is to be certain that the brewmaster or owner and the fabricator agree on what is to be provided. If threaded flanges are welded into the tank, they should be tapped out after welding; in many cases they are tapped after the interior has been coated with the result that bare steel is exposed to the beer in the space between the brass fitting and the threads. This can be eliminated by bushing all threaded openings with brass bushings before coating the tank and allowing the coating to seal off the steel threads on the inside. The bottom outlet on chip tanks should be a size larger to provide for a brass bushing and an adjustable strainer. Brackets should be welded to the tank for attaching pipe hangers. In many cases these are not provided and cannot be put on later without damaging the interior coating. High vertical tanks should be provided with interior brackets for supporting the platforms used in cleaning.

The manhole is one of the most important fittings on a brewery tank and the one most often slighted by inexperienced fabricators. In some cases a special design has been worked out and proven satisfactory, but if such is not the case, the safest procedure is to provide a wide bearing surface, not less than 1 inch, on the cover and openings; a flanged-in opening, banded, or a welded-in ring 1 inch thick will provide the proper surface; both the opening and the cover should be machined. A pure gum gasket 1¼ inches wide and ¼ inch thick will give a fine seal. Rounding the edges of the opening helps the brewery worker when climbing in and out of the tank. The cover itself can be of cast steel, malleable iron, or pressed steel. Cast iron is sometimes used but not recommended.

If the hinge lugs were to be broken off of one cover plate, the inconvenience and trouble caused thereby would go a long way toward offsetting the saving in the original cost. The hinge arm and the yoke should be of steel in any case and the hinge pins should be of brass or other non-corrosive metal. A lot of trouble has been caused by manhole fittings corroding to such an extent that it was almost impossible to open them with anything less than a battering ram. A great deal of care should be used in adjusting the manhole covers in place so that they open and close properly and fit correctly. The center of the manhole should be about three feet above the floor.

Supports. A tank support resting directly upon the floor and in contact with washing and drainage water should be of cast iron; rolled steel supports rust out in a few years. Concrete or wood supports are objectionable as are any supports of any great size which hinder the proper cleaning of the floors. The round jack-like supports are ideally suited to brewery work and if the number used and the method of attaching are in accordance with the specifications of the jack manufacturers no trouble will be experienced. Care should be taken to see that nothing can get under the supports, that is, between the support and the floor, for that would be an excellent place for an infection to start.

Coating. The interior of all tanks should be thoroughly sand-blasted with either good sharp silica sand or steel grit, after which the interior coating should be applied to hot steel before the surface has become oxidized. Heating the tank is necessary when the plastic coatings are used, as they will not adhere to a cool surface. It is also very essential to clean the surface of all dust. Oxidation of a freshly sand-blasted steel surface proceeds rapidly and, even though it cannot be seen with the naked eye, delay in applying the coating will cause failure after the tank has seen some service, though the coating may have seemed to be good when put on. Failure of the coating usually takes place first in the bottom of the tank, indicating greatest wear at that point or, what is perhaps more true, that the bottom was not as clean as the remainder of the tank, not heated as well, or was allowed to oxidize.

The outside of the tank should be thoroughly cleaned and at least one shop coat of primer applied. Heads that have been dished hot have a great deal of scale on the surface, some of it fairly loose. If the heads are sand-blasted on the outside to remove that scale, a better job can be delivered to the customer.

Setting the Tanks. A layout and setting plan should be made before any material is ordered or any work done. Plenty of aisle space should be provided, 4 feet in fermenting cellars and 3 feet in storage cellars if possible. There should be room enough under and over and around the tanks for cleaning, painting, pipe-fitting, etc. Steel tanks should not be placed too close to refrigerating coils; ice forming inside the tank causes turbidity of the beer. Supports should be located to clear gutters, etc.; man-holes located so that free entry into tanks with ladders, etc., is provided. When the tanks are set, they should be placed exactly as called for on that plan.

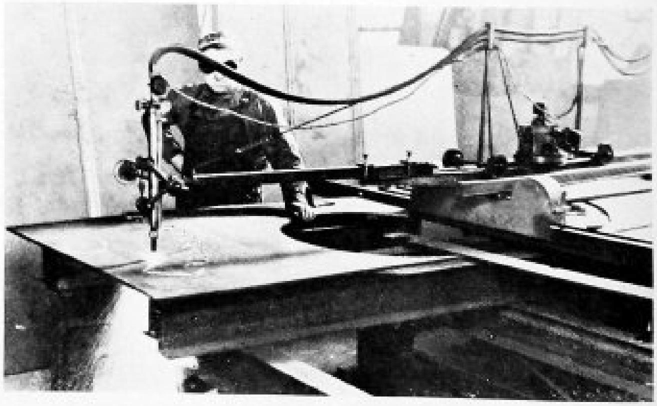
After the job is completed all tanks should be re-inspected for defects in the coating or for any damage done during installation so that when finally the job is turned over to the brewmaster he can feel that he has fine equipment to help him make good beer.

Insulated Electrode Holder

It is estimated that 90 percent of the flashes welders get are caused by contacting the ordinary bare type holder with grounded parts. The Jackson insulated electrode holder is recommended by its manufacturer as a means for eliminating these flashes. Injuries to light work, due to accidental grounding, are also avoided, so that the safety factor as an advantage is matched by the elimination of spoiled work. Avoidance of breaking the arc through striking an uninsulated holder against grounded parts while welding naturally increases welding speed.

The Jackson holder is made of a special alloy having unusual strength, wear-resisting qualities and high conductivity. It is said to have two or three times the useful life of a bare type holder. Cable connection may be clamped or soldered. Handle and jaws are protected by molded, non-conductive, non-burnable insulating parts, securely attached. The holder is manufactured and sold by the Jackson Electrode Holder Company, Detroit, Mich.

GRISWOLD PRICE, assistant manager of sales of the St. Louis district of the Illinois Steel Company, the Carnegie Steel Company, and the Tennessee Coal, Iron & Railroad Company, has been promoted to manager of sales for these companies, with the same headquarters.



Oxy-acetylene flame used for cutting shapes

Complicated shapes can easily be made in this way on a production basis as shown in the illustration where an irregular shape is being cut from steel plate.

Front view of D. L. & W. 4-8-4 type locomotive

American Locomotive Company delivers twenty "Pocono" Type

LOCOMOTIVES FOR THE LACKAWANNA

The American Locomotive Company is now completing delivery of 20 locomotives of 4-8-4 type to the Delaware, Lackawanna & Western which will be used to handle either fast freight or heavy through passenger trains between Hoboken, N. J., and Buffalo, N. Y., a through run of approximately 400 miles in length. Upon completion of delivery of these locomotives the road will have a total of 55 locomotives of this general type, all of which have been built by the American Locomotive Company.

The first locomotives of this type acquired by the Lackawanna were received in 1927 and were designed for heavy passenger service. They were numbered from 1501 to 1505, had 27-inch by 32-inch cylinders, 77-inch drivers, carried 250 pounds steam pressure, weighed 421,000 pounds, and had a rated tractive force of 64,500 pounds.

The next lot of 20 locomotives, numbered from 1601 to 1620, were designed for heavy fast-freight service and were received in 1929. They had 28-inch by 32-inch cylinders, 70-inch drivers, carried 235 pounds steam pressure, weighed 418,000 pounds, and had a rated tractive force of 71,600 pounds.

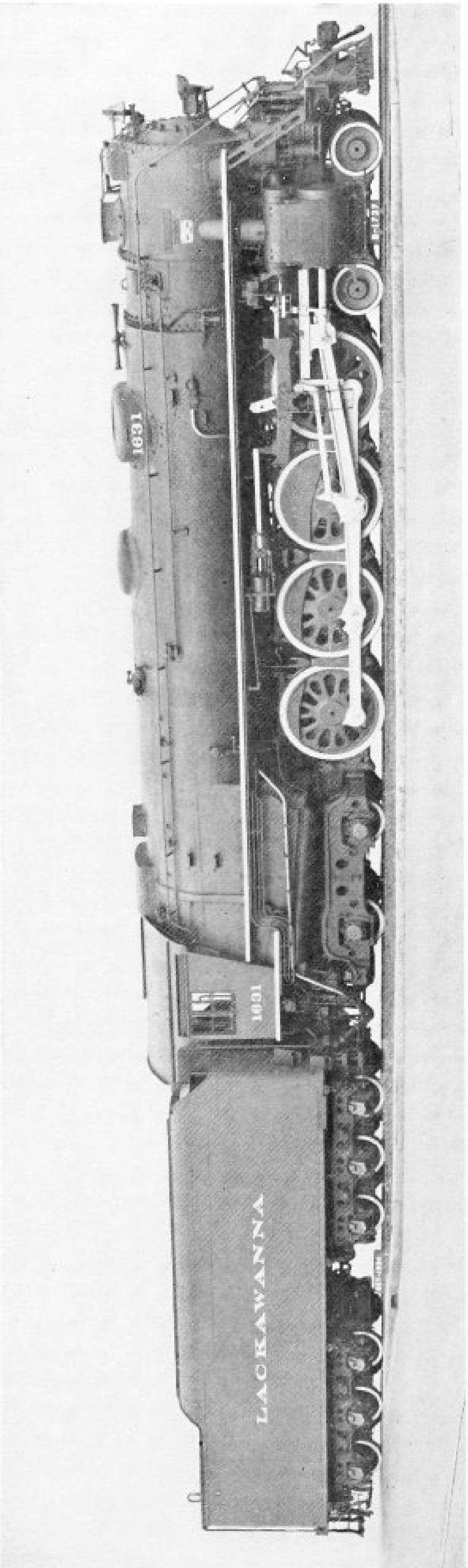
A third lot, 10 locomotives, numbered from 1621 to 1630, were delivered in 1932. They were of the same general design as the previous lot, but contained several improvements in design, including Type E in place of Type A superheaters. Their weight was increased to 429,000 pounds.

The present lot now being delivered are numbered from 1631 to 1650 and, as stated, are intended for handling either passenger or freight traffic. They have 28-inch by 32-inch cylinders, 74-inch drivers, carry 250 pounds steam pressure, have a rated tractive force of 72,000 pounds and weigh 447,000 pounds.

Comparing these locomotives with previous ones numbered in the 1600 series, it will be noted that by an increase in the steam pressure from 235 pounds to 250 pounds the tractive force has been maintained with the same size cylinders despite the increase in diameter of the driving wheels from 70 inches to 74 inches. The suitability of a properly designed 4-8-4 locomotive for handling both modern fast freight and heavy passenger trains is making the type a closer approach to a general purpose locomotive that any other type that followed the old American or 4-4-0 type which 50 years ago was practically the universally used wheel arrangement on road engines.

Comparison of Lackawanna 4-8-4 Type Locomotives

Road Nos.	1501 to 1505	1601 to 1620	1621 to 1630	1631 to 1650
Date built	1927	1929	1932	1934
Tractive force, lb.	64,500	71,600	71,600	72,000
Weight of engine, lb.	421,000	418,000	429,000	447,000
Weight on drivers, lb.	269,000	262,000	271,000	274,000
Cylinders, in.	27 by 32	28 by 32	28 by 32	28 by 32
Drivers, diam., in.	77	70	70	74
Steam pressure, lb.	250	235	235	250
Heat. surface, firebox, total, sq. ft.	493	515	511	496
Heat. surface, tubes and flues, sq. ft.	4,700	4,621	4,934	4,992
Tube length, ft.-in.	21–6	21–6	21–6	21–6
Superheat surface, sq. ft.	1,324	1,324	2,243	2,180
Grate area, sq. ft.	88.2	88.2	88.2	88.2
Superheater	A	A	E	E
Tender, water, gal.	12,000	15,000	15,000	16,000
Tender, coal, tons	14	22	22	26



Delaware, Lackawanna & Western 4-8-4 type locomotive for fast-freight and heavy passenger traffic—Built by American Locomotive Company

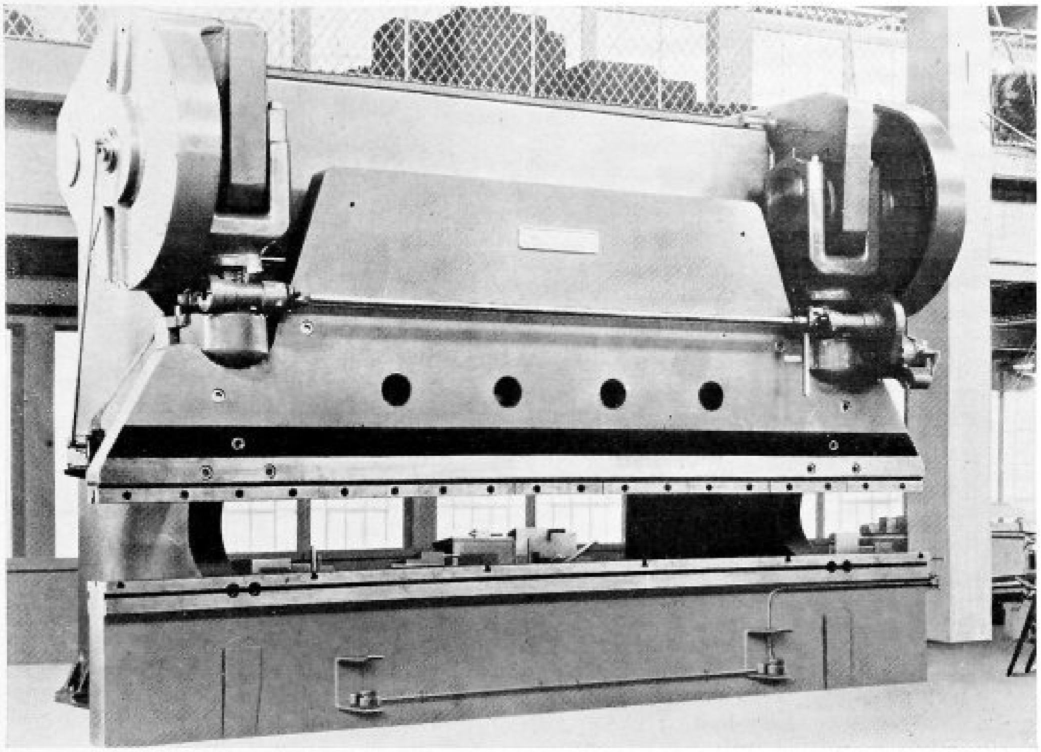
Principal Boiler Details of the D. L. & W. 4-8-4 Type Locomotives

Railroad	D. L. & W.
Builder	American Locomotive Co.
Type of locomotive	4-8-4
Road Nos.	1631—1650
Service	Freight and passenger
Boiler:	
Type	Conical con.
Steam pressure	250 lb.
Fuel	Soft coal
Diameter, first ring, inside	84¼ in.
Firebox, length and width	132 in. by 96¼ in.
Height mud ring to crown sheet, back	72¼ in.
Height mud ring to crown sheet, front	92 in.
Top of grate to lowest tube	26⅞ in.
Arch tubes, number and diameter	3—4 in.
Combustion chamber, length	66$^1/_{16}$ in.
Tubes, number and diameter	82—2¼ in.
Flues, number and diameter	202—3½ in.
Length over tube sheets	21 ft. 6 in.
Grate type	Firebar
Grate area	88.2 sq. ft.
Heating surfaces:	
Firebox and combustion chamber	374 sq. ft.
Arch tubes	27 sq. ft.
Syphons	95 sq. ft.
Firebox, total	496 sq. ft.
Tubes	1,033 sq. ft.
Flues	3,959 sq. ft.
Tubes and flues	4,992 sq. ft.
Total evaporative	5,488 sq. ft.
Superheating	2,180 sq. ft.
Combined evaporative and superheating	7,668 sq. ft.
Special equipment:	
Superheater	Elesco, Type E
Feedwater heater (18)	Worthington
Exhaust steam injector (2)	Elesco
Stoker	Standard BK
Tender:	
Style	Rectangular W. B.
Water capacity	16,000 gal.
Fuel capacity	26 tons
Boiler proportions:	
Tractive force ÷ combined heating surface	9.4
Tractive force × diameter drivers ÷ combined heating surface	752
Combined heating surface ÷ grate area	87
Firebox heating surface ÷ grate area	5.62
Firebox heating surface, per cent of evaporative heating surface	9.04
Superheating surface, per cent of combined heating surface	28.4

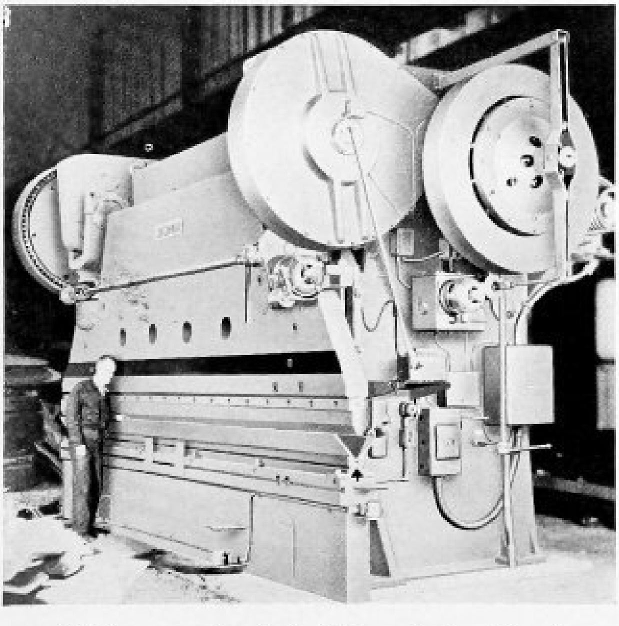
The boiler, which is of conventional design, is of liberal proportions in order to provide ample generating capacity to sustain a maximum of 4025 potential horsepower over long continued periods. The inside diameter of the boiler at the first course is 84¼ inches. The firebox is 132 inches by 96½ inches inside which gives a grate area of 88.2 square feet. The grates are of the Firebar type. Bituminous coal is used as fuel and is fed by a B-K Standard automatic stoker. Two Nicholson thermic syphons and three arch tubes are fitted in the firebox and one additional syphon in the combustion chamber which is 66$^1/_{16}$ inches long. There are 82 tubes, 2¼ inches in diameter, and 202 flues, 3½ inches in diameter, 21 feet 6 inches long. This gives a heating surface of 496 square feet in the firebox and combustion chamber and 4992 square feet in the tubes and flues, or a total of 5488 square feet evaporative heating surface.

The superheater is an Elesco Type E with 2180 square feet of surface and is expected to deliver the required amount of steam at a final temperature of between 700 and 750 deg. F. Worthington feedwater heaters are applied on the first 18 locomotives and Elesco exhaust-steam injectors on the last two locomotives. Superior flue blowers, Barco low water alarms and Franklin Butterfly firedoors are included.

The tender tank is mounted on a General Steel Castings Corporation water bottom underframe weighing 31,000 pounds. It is of the rectangular type having a capacity for 16,000 gallons of water and 26 tons of coal, although 28 tons may be loaded by heaping. The tender is carried by six-wheel trucks of General Steel Castings design. Brake rigging is of the clasp type furnished by the American Steel Foundries. The loaded weight of the tender is 313,000 pounds.



World's largest press brake for forming, flanging and multiple punching



Welding was used extensively in construction of machine

PRESS BRAKE

World's largest brake will handle plates up to 18 feet in length

Constructed to handle steel plates up to 1 inch in thickness in lengths up to 12 feet and steel plates ¾ inch in thickness in lengths up to 18 feet, the largest machine of its type ever built for bending, flanging, forming and multiple punching has recently been completed by The Cincinnati Shaper Company, Cincinnati. The press brake has been installed in the By-Products division of Lukens Steel Company at Coatesville, Pa., and will enable Lukens to supply bent or formed plates in extremes of thickness and length as required by its customers as well as for use in the manufacture of the welded steel structures produced by the Lukenweld division for machinery and equipment manufacturers.

The press brake is of the characteristic design of the standard line of all-steel press brakes manufactured by The Cincinnati Shaper Company. It has a clear distance between the housings of 12 feet 6 inches with an overall working length of die surface of 18 feet through a 14-inch throat.

The ram has a stroke of 6 inches and an adjustment of 6 inches, with a distance of bed to ram, stroke down and adjustment up of 14 inches. Independent adjustment to each end of the ram is provided to take care of fade out or cone work. Two speeds are provided through a gear shift transmission so that the machine may be operated at either five strokes per minute or twenty strokes per minute. The clutch is hydraulically operated by electrical control from each or all of several stations for convenient and effortless operation.

One set of five dies gives complete range for general purpose work in plates ranging in thickness from No. 10 gage up to 1 inch. The machine will develop safe working loads up to 1000 tons. A direct-reading load indicator, which can be seen just back of the throat on the right housing, shows the load developed during any operation of the press, and also has a maximum load hand, recording continually the heaviest load to which the machine has been subjected at any time.

This press brake was developed, designed and constructed by The Cincinnati Shaper Company, and is of steel construction throughout, using heavy steel plates of analyses especially adapted to flame-cutting and welding which were supplied by Lukens Steel Company. The housings, flame-cut from two steel plates 8 inches in thickness, 87 inches in width, and 13 feet 8 inches in length, weigh 33,000 pounds each. The bed and ram were flame-cut from two steel plates 7 inches in thickness, 72 inches in width, 18 feet in length and weigh 31,000 pounds each. The main drive gears are of welded steel construction, with high-carbon steel providing the requisite tooth strength and wear resistance in the gear rim. The gear guards, which also act as outer auxiliary bearings, are of welded steel construction. All welding was done with Fleetweld rods furnished by Lincoln Electric Company. The curved rim of the gear guards and the heavy top brace between the housings, which is almost a complete box section in one piece, were formed on the machine itself before they were put in place. The total weight of the machine complete is approximately 145,000 pounds.

Among the interesting features of the design of the machine is the employment of a divided pitman which, in conjunction with the cylindrical supports for the bed and ram, assures that the load of the press brake is carried directly on the center line of the housings, thus avoiding eccentric loading. The screw in the pitman is a heat-treated nickel-chromium alloy steel forging cut with a buttress thread, having a full ball and socket joint, with ball ends hardened and ground. Ram adjustment is accomplished by an independent motor through a hardened and ground worm and bronze worm wheel on the screw. In connection with the independent adjustment of each screw, dial indicators furnished by B. C. Ames Company of Waltham, Mass., show the position of the screw or the ram with relation to the bed and also the position of each screw with reference to the other. Furthermore, for this independent adjustment of each end, pivotal slide bearings have been provided, running on hardened and ground steel guides on the face of the housing, with bronze gibs in the slides. The ram adjusting shaft bearings were supplied by The Timken Roller Bearing Company.

Another interesting feature is the use of ball bearings supplied by the New Departure Manufacturing Company under the steel flywheel, which is 56 inches in diameter, weighs 4000 pounds, and runs at 600 revolutions per minute. The flywheel shaft is mounted on two double Timken bearings. The multiple disk clutch is contained in the outer face of the flywheel. The friction disks are 32 inches in diameter, and of the Johns-Manville Corporation's brake block.

The several electrical control stations are arranged with cut-out switches so the machine may be operated from any one station or may require the operator at each point to push his button before engaging the clutch as a matter of safety. The control further permits operation with the machine making either a complete cycle with the stop at the top, or for continuous running, or for a jogging or hunching operation. General Electric Company's floor type push buttons are used, with the solenoid, limit switch, contactor and jog switch of the electric clutch control being furnished by Cutler-Hammer, Inc.

An oiling system supplied by Manzel Brothers Company, Buffalo, with two stations, one on each housing, furnishes complete automatic lubrication. The press brake is driven by a General Electric 50-horsepower high torque motor, connected by vee-belts to the flywheel.

Pneumatic Impact Wrench

Imagine a small machine weighing about twenty pounds that will spin down a 1-inch or larger nut at 700 revolutions per minute and then give it a series of smart torsional blows at the rate of 1400 a minute to tighten it as securely as desired! That is just what this newest and most remarkable of all pneumatic tools does.

In the Ingersoll-Rand Pott impact wrench a principle entirely new to the pneumatic tool field is brought into play—that of the rubber "accumulator." This is a cylindrical block of special rubber interposed between the "multi-vane" air motor and the chuck. In operation, the torque from the motor is applied to the accumulator which, in twisting, becomes shortened, lifting the "hammer" from engagement with the "anvil." The hammer is then released and is spun forward to the next engagement, thus delivering a powerful blow, with considerable mass behind it, to the anvil.

New wrench specially adapted to locomotive boiler work

These torsional impacts occurring at the rate of 1200 to 1400 blows a minute exert a more powerful turning effect than is possible with any other portable wrench. This type of turning action, new to a power wrench, makes it possible to remove nuts which could not be taken off except by splitting with a chisel or burning with a torch.

One man operates this wrench with ease. The accumulator absorbs the torque and eliminates the danger of shock or injury to the operator. The cushioned action makes it possible to operate the impact wrench on high places or in positions that would be unsafe with any other type of machine.

It would be unwise to attempt to predict the limitless number of uses to which this new tool will be put or the fields it will enter. Certainly there is a need for a tool of this nature in railroad shops, refineries, shipbuilding, structural steel shops and field jobs, automotive and other manufacturing plants and, in fact, wherever considerable nut running, whether applying or removing, is done.

For additional information concerning the Ingersoll-Rand Pott impact wrench, address Ingersoll-Rand Company, New York City, mentioning Boiler Maker and Plate Fabricator.

Industry and Accidents in 1934

By W. H. Cameron*

Industry may view preliminary 1934 accident statistics with mixed feelings. The nation's industrial organizations will regret a seven percent increase in occupational fatalities, but at the same time, may find some measure of comfort in the fact that this proportionate increase was smaller than the 8.7 percent gain in all types of accidents.

Still more important than bare figures, however, loom certain developments during an adverse year which are more than heartening. While 1934 saw all accident fatalities rise from 91,087, as of 1933, to 99,000, thus approximating the all-time high record of 99,300 deaths established in 1930, it also witnessed accomplishments of great importance.

Occupational accidents claimed 15,500 lives, it is estimated, or 1000 more than in 1933. These occupational deaths, however, were far outstripped by gains in motor vehicle and home fatalities. Motor vehicle deaths rose to 35,500—a gain of 13 percent—to establish a new record in highway slaughter. The previous record, 33,675 fatalities, was reached in 1931. Home accident deaths in 1934, increased by 3000, trailed closely after the motor vehicle, being estimated at 33,000. The rest of the 99,000 fatalities fell into the "other public" group of the National Safety Council's classifications.

As discouraging as these figures may be, 1934 was not an unprofitable year for the safety movement—and industry probably led the way in making valuable contributions.

Outstanding among the achievements of individual industrial units, was the establishment of the world's record for operation without a single lost-time accident. On November 1, the Western Clock Company, of La-Salle, Ill., a Council member employing 2300 persons, had amassed a grand total of 10,029,681 accident free man-hours. This record, which dated from December 17, 1931, and is still continuing, was made in a plant where such so-called hazardous devices as power presses, screw machines and tool-making machines, are almost continually in use. If 1934 had brought no other compensation, this accomplishment, alone, should serve as inspiration.

In keeping its accident fatality gains proportionately lower than that for any other major classification, industry labored under severe handicaps. There was abroad a spirit of unrest beyond the control of safety departments and which may have proved a tremendous impediment to effective accident-preventive effort in more than one instance. Safety programs often were complicated by the hiring of new employees, many of whom were inexperienced or through idleness had lost their working skill. Then, too, the very magnitude of the numbers returning to work, in need of careful instruction and supervision during the re-employment process, makes one realize how taxed were the resources and facilities of numerous safety departments.

Industry, however, made one safety contribution to the public welfare which should be of lasting value and project its influence in the safety movement far into the future. During 1934, the National Safety Council served the Federal Government by directing accident prevention work on all the vast projects of the Civil Works Administration. To organize activities, members of the Council, mostly industrial concerns, loaned their safety directors to the C.W.A. for brief periods. Of the four million men employed by C.W.A., thousands had never received training in accident prevention and possessed only meager or out-moded information on first aid. Much of this training will endure.

During the year, the Engineering Department of the Army, following the lead of the Navy, which for years has conducted safety activities along industrial lines with extremely creditable results, also inaugurated accident prevention work with concommitant savings far in excess of the expenditure involved.

C.W.A. traffic surveys brought to light much needed information on accident causation, from which industry, as well as the public, will profit.

In 1934, industry also entered into an experiment which may yet turn down the rising curve on the graph of home, motor vehicle and public accidents. A pioneering venture, it has been organized upon a small scale in order that the program may be conducted with close supervision and concentrated effort.

Figures gathered by many plants during recent years indicate that many more workers are injured off duty than during employment hours. The Western Electric Company, Chicago plant, for example, during a four-year period, lost two employees at work through accidents, while 35 lost their lives outside of working hours.

Working on the theory that industrial safety progress has been made through the influence of the employer and the willingness of the employee to co-operate, 16 companies in New York State, with 9000 employees participating, inaugurated a six-month campaign to bring safety into the lives of their workers after leaving the plant.

The campaign, known as "After the Whistle Blows," is entering upon its fourth month, being sponsored by the National Safety Council in New York City. The program is so organized that workers carry safety contest activities into their homes and enlist their families. It is broad in outline and embraces driving instruction, home inspection, first aid instruction to employees' families, and also calls for inter-plant contests.

Should this experiment indicate that workers and their families are susceptible to this form of safety education, 1934 will have been a year of signal advancement

* Managing director, National Safety Council.

in safety, by providing a vital approach to the home, public and traffic safety problems.

In reviewing 1934, it is apparent that it was a year fraught with difficulties. Yet, despite the adverse statistics, it really was a year of growth; the adversity has merely stimulated the safety leaders of the country to greater and more determined efforts, with the result that we may look back to 1934 as a year of revitalization, in which may be the roots of future growth.

Power Show Reflects Confidence

Revival of confidence in the capital goods industries was revealed through the business success which rewarded exhibitors at the Eleventh National Exposition of Power and Mechanical Engineering, held at Grand Central Palace, New York, December 3 to 8, 1934. Courage and the success that responds to it were in the air. Plants were being rebuilt and re-equipped. New purchasing agents arrived to invite bids for the equipment of factories once more approaching an effective volume of production. Exhibitors in every part of each floor reported encouraging reactions and results. Large orders were placed and the displayers of small items, such as files, for instance, reported that the visiting audience was critical, open-minded and in the mood to buy.

The Exposition has an attendance restricted to those directly concerned and able to profit by its specialization and scope. The number of companies and organizations exhibiting was 245. At the Exposition in 1932—it is a biennial event—37,980 were admitted by registration. This year the figure was 36,798. Such continuing interest in the Power Show is significant, especially this year with the obvious absence of curiosity seekers and the serious and intelligent interest displayed by visitors.

Cutting power service costs was the keynote of this year's Power Show and a majority of the exhibits were developed to capitalize upon this trend. The years of industrial inactivity provided research and development departments the time to catch up in their work and to carry design forward. The research results were design improvement, refinement of operation, and new economies in every field which the Exposition includes. In boilers and heaters, in transmission and piping, in valves and fittings, in materials of construction, refractories and insulators, likewise in the electrical section, and with respect to instruments of precision—in all of the divisions, refinement, efficiency and economy were notable as achievements.

The combustion of fuels is a subject closely related to power production, not to mention heating, both industrial and domestic. The Power Show covered the complete range from the fuels themselves to their translated effect in terms of various forms of energy. Conventionally the fuels included all phases—solid, liquid, and gaseous. Cutting power service costs was interpreted in terms of fuel economy achieved through design improvements and new equipment. The showing of stokers was concentrated on industrial power applications as opposed to the domestic types. A new power type stoker was equipped with worm feed and firebox distributor for heavy duty service.

In the same section were burners, ovens, water heaters, furnaces, melters, forges, indirect heaters, unit heaters, high pressure burners, gas heated tentering frames. In connection with the combustion of fuels a new air volume regulator was shown. There were automatic fluid pressure regulators, pump governors, auxiliary controllers and back pressure valves. Steel tubular firebox boilers were shown for coal, oil, or gas firing. A modern domestic hot water system emphasized the fact that the hot water heating coil was so designed that the ordinary necessity of a storage tank was eliminated. Heating boilers evidenced a trend toward compactness. Especially those for domestic installations reflected the movement toward improved industrial design. Boiler cleaning compounds were well represented. One company created interest by a demonstration of spraying molten metal. Practically this is used to coat condenser tubes and for other applications, but the news reels caught it in the act of turning the heels of ladies' evening slippers into tones of silver or gold.

A.S.M.E. Code for Unfired Pressure Vessels—1934 Edition

The American Society of Mechanical Engineers has recently issued the 1934 Edition of the Code for Unfired Pressure Vessels. The object of the Code covering the construction of unfired pressure vessels is to provide a generally acceptable basis for the fabrication of safe vessels. Since there undoubtedly will be innumerable variations of the design and uses made of these vessels, it is manifestly impossible to provide rules which will be applicable to all the great variety of problems which may arise. When necessary, however, the Committee is glad to give consideration to special problems which may be brought to its attention.

There have been several changes made from the previous edition and considerable new matter has been added. Notable among these are a comprehensive set of rules for vessels subjected to external pressure; these rules are the result of extensive research and constitute an entirely new development in rules for engineering design. They were formulated by the Special Research Committee on the Strength of Vessels under External Pressure upon the request of the Boiler Code Committee. In the course of this work a large amount of experimental work was contributed by the U. S. Navy Department and certain interested manufacturers.

In addition, the rules in the Code for computation of heads and flanges have been considerably extended so as to provide in a very comprehensive manner rules for the entire subject of bolted flanged connections for application to cylindrical shells, nozzle necks, and all forms of pipe constructions. At the same time the question of flat head construction was covered and rules were adopted to cover broadly the computation of flat heads of all types, including welded and integral heads as well as those attached by bolting or riveting. The formulation of these rules was participated in by representatives of the Sectional Committee of the Society on Pipe Flanges and Fittings and of the American Petroleum Institute. The Committee is indebted for gathering and editing these new data to the Subcommittee on Special Design.

Further changes and adjustments will undoubtedly need to be made from time to time, as the art progresses and as future practice may indicate.

The Boiler Code Committee does not approve, recommend, or endorse proprietary or specific designs, nor does it assume to limit in any way the builders' right to choose any method of design or form of construction that conforms to the code rules.

Copies may be obtained from the Secretary of the A.S.M.E. Boiler Code Committee, 29 West 39th Street, New York.

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Contents

Republic Steel Considering Extensive Consolidations

Developments in the steel business and financial markets and the number of proxies being received indicate the probability of an early consolidation of the Republic Steel Corporation and the Corrigan, McKinney Steel Company and acquisition by the merged corporation of the Truscon Steel Company, T. M. Girdler, president and chairman of the board of the Republic Company, said today.

"I am convinced by every evidence," he said, "that America is again moving forward into a new cycle of greater achievement, greater production, and that the proposed merger, equips Republic to play a highly important part in this new era.

"Proxies for more than two-thirds of the common stock and over 60 percent of the preferred stock of the Republic Steel Corporation have been received in favor of the plan," Mr. Girdler said. "In order to insure the necessary vote to effectuate the consolidation plan at a stockholders' meeting February 5, the consent of only seven percent additional preferred stock is required. It is, therefore, important that every stockholder, no matter how small his holding, forward his proxy at the earliest possible moment.

"The shares for which proxies have not been received are, for the most part, those of small holders scattered throughout the country whose names are not known to the company as stockholders.

"Stockholders of the Corrigan, McKinney Company already have indicated their willingness to approve the consolidation."

Consolidation of the companies and the attendant reorganization of Republic's capital structure, Mr. Girdler said, are intended not only to strengthen Republic's position as the third largest producer in the steel industry and to enable it to take advantage of the opportunities for increased business which are now being developed as the country's economic condition improves, but also to pave the way for the resumption of dividends on the preferred stock.

Outstanding preferred shares that are not exchanged for new prior preference stock will be junior to the new preference stock after the consolidation is completed and will not be entitled to receive dividends until full dividends on the new prior preference stock have been paid, Mr. Girdler said.

Trade Publications

X-Ray Service.—A leaflet, issued by the St. John X-Ray Service, Inc., Long Island City, N. Y., outlines the 10-year record of pioneering experience of the St. John welding laboratories devoted to industrial radiography.

Electric Drill.—Under the title "A Step Ahead in the Design of High Frequency Electric Portable Tools" the Buckeye Portable Tool Company, Dayton, O., describes a new Hercules high-frequency electric drill. This drill is described as a powerful and sturdy general purpose tool. It is equipped with the new Hercules cool-running high-frequency motor and is obtainable with side handle and switch, as well as in the spade handle design.

Compressors.—Chicago Pneumatic Tool Company, Chicago, Ill., has issued a bulletin describing its newly designed horizontal, single-stage compressor, type "T." These compressors are double-acting and water cooled, arranged for belt and direct-connected motor drive for permanent or semi-permanent installations. They are used for compressing air and most commercial gases. Complete details, with numerous illustrations, explain the construction features of this type compressor.

Coated Electrodes.—The Air Reduction Sales Company, New York, has issued a leaflet describing shielded arc electrodes, Nos. 78, 79, and 81. Airco rods Nos. 78 and 79 are heavily coated steel electrodes possessing a quieter arc and smoother flow due to their coating. The rods have a tensile strength of from 60,000 to 75,000 pounds per square inch, an elongation of from 22-30 percent and a higher resistance to corrosion than mild steel.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on practical boiler shop problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given special permission to do so.

By George M. Davies

Calculating Side Braces

Q.—Will you please publish in your Questions and Answers Department the proper formulas to show the method of figuring the side braces for the oval of an Economic type boiler. If possible, will you choose weldless braces, 4-pitch long, pitch 6½ by 10, riveted to the side sheet, 100 pounds pressure, or if you choose, use a hypothetical case to show this figuring. W. M. G.

A.—The A. S. M. E. Boiler Code Rules and formulas governing the design and construction of the side braces for the oval of an Economic type boiler illustrated in Fig. 1 are as follows:

P-203 (a). The maximum spacing between centers of rivets or between the edges of tube holes and the centers of rivets attaching the crowfeet of braces to the braced surface, shall be determined as in Par. P-199, using 135 for the value of C.

P-199. The maximum allowable working pressure for various thicknesses of braced and stayed flat plates and those which by these Rules require staying as flat surfaces with braces or staybolts of uniform diameter symmetrically spaced, shall be calculated by the formula:

$$P = C \times \frac{T^2}{p^2}$$

where

P = maximum allowable working pressure, pounds per square inch.

T = thickness of plate in sixteenths of an inch.

p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, in.

P-209. The least cross-sectional area of a stay shall be taken in calculating the allowable stress, except that when the stays are welded and have a larger cross-sectional area at the weld than at some other point, the strength at the weld shall be computed as well as in the solid part and the lower value used.

P-220 (a). The full pitch dimensions of the stays shall be employed in determining the area to be supported by a stay and the area occupied by the stay shall be deducted therefrom to obtain the net area. The product of the net area in square inches by the maximum allowable working pressure in pounds per square inch gives the load to be supported by the stay.

(c) The maximum allowable stress per square inch at point of least net cross-sectional area of staybolts and stays or braces shall be given in Table P-8. In determining the net cross-sectional area of drilled or hollow staybolts, the cross-sectional area of the hole shall be deducted.

(d) The length of the stay between supports shall be measured from the inner faces of the stayed plates. The stresses are based on tension only. For computing stresses in diagonal stays, see Pars. P-221 and P-222.

P-223. *Design of Braces and Brace Connections.* All rivet and pin holes shall conform to the requirements in Par. P-253 and the pins shall be made a neat fit. To determine the sizes that shall be used proceed as follows:

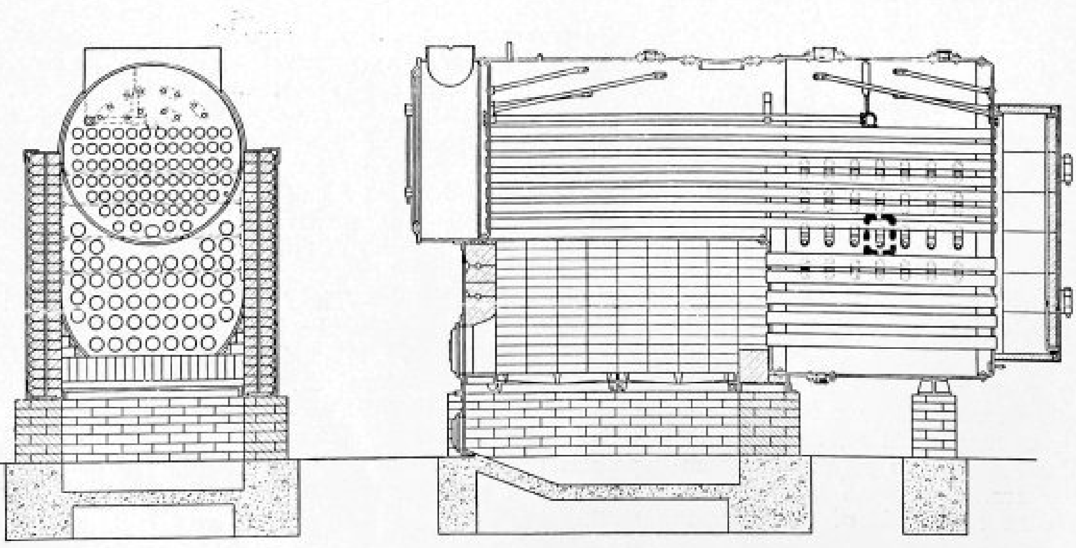

Fig. 1—Sectional elevation showing method of bracing and staying pressure parts of economic boiler

(1) Determine the "required cross-sectional area of the brace," by first computing the total load to be carried by the brace, and dividing the total load by the value of allowable stress for unwelded stays or braces given in Table P-8.

(2) Design the body of the brace so that the cross-sectional area shall be at least equal to the required cross-sectional area of the brace for unwelded stays or braces. Where the stays or braces are welded, the cross-sectional area at the weld shall be at least as great as that computed for a stress of 6000 pounds per square inch, (See Table P-8).

TABLE P-8. MAXIMUM ALLOWABLE STRESSES FOR STAYBOLTS AND STAYS OR BRACES

Description of staybolts and stays or braces	Stresses, pounds per square inch: For lengths between supports not exceeding 120 diameters [1]	For lengths between supports exceeding 120 diameters [1]
(c) Unwelded stays or braces and unwelded portions of welded stays or braces............	9,500	8,500

[1] Diameters taken at body of stay or brace.

(7) Make the net sectional areas through the sides of the crowfoot, tee irons, or similar fastenings at the rivet holes at least equal to the required rivet section, that is, at least equal to 1¼ times the required cross-sectional area of the brace.

(8) Make the combined cross-sectional area of the rivets at each end of the brace at least 1¼ times the required cross-sectional area of the brace.

Fig. 2 illustrates the conditions as outlined in the question. Applying Paragraph P-203 (a), we have

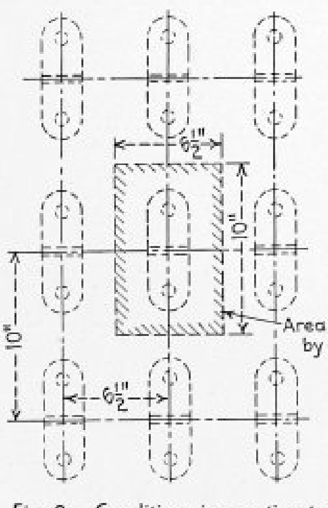

Fig. 2.—Conditions in question to be solved

$$P = C \times \frac{T^2}{p^2}$$

assuming $T = 7/16$ inch, $C = 135$, $p = 6\frac{1}{2}$ inch (See Fig. 2.)

$$P = 135 \times \frac{7^2}{6\frac{1}{2}^2}$$

$$P = \frac{135 \times 49}{42.25}$$

$P = 154$ allowable working pressure spacing of rivets.

Paragraph P-209 does not apply with regards to welded braces as the braces specified in the question are weldless.

Assuming 2½ x 3/8 body the least cross-sectional area would be 0.8375 square inch.

Applying Par. P-220 (a) we have

Full pitch dimensions of stays are 6½ x 10; with 2½ x 3/8 braces the area to be stayed is,

6.5 x 10 – (2½ x 3/8) = 64.1625 square inches.

The load to be supported by the brace would be, assuming 100 pounds boiler pressure as given in the question, we have

64.1625 x 100 = 6416.25 pounds.

Par. P-220 (c). The maximum allowable working pressure in pounds per square inch as taken from table P-8 would be 9500 pounds per square inch. The total load that that can be carried on each 2½ x 3/8 stay would be:

0.8375 x 9500 = 8956 lbs. allowable load on each stay.

The actual load on the stays is 6416.25 pounds: therefore the stays are of ample size.

Par. P-220 (d). The length of the stays is measured from the inner faces of the stayed plates as illustrated in Fig. 1.

P-223 (1)

Required cross-sectional

$$\text{area of brace} = \frac{6416.25}{9500} = 0.6753 \text{ square inch.}$$

P-223 (2). The cross-sectional area of the assumed brace is 2½ x 3/8 = 0.8375 square inch which is greater than the required cross-sectional area 0.6753 square inch and is therefore satisfactory.

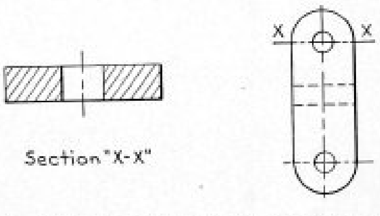

Fig. 3.—Net area through rivet hole of brace foot

P-223 (7). The net sectional area through the rivet hole of the brace foot as illustrated in Fig. 3 should be at least 1.25 x 0.6753 = 0.8441 square inch.

Par. P-223 (8). The cross-sectional area of the rivets in the brace foot at each end should at least be equal to 1.25 x 0.6753 = 0.8441 square inch.

Joints in Vertical Extended Firebox Boiler Shell

Q.—Herewith is a sketch showing the vertical extended firebox type of boiler. We wish you would advise us if you consider the joint *A* and *B*, as being part of the shell, or would the joint be figured as a flat surface, as, of course, the inner and outer boxes are stayed with suitable stay bolts. We have seen joints of this kind made of double riveted lap, but in our opinion it should be calculated the same as the shell, and would appreciate your advice regarding same. W. T. F.

A.—The wrapper sheet or outside firebox sheet, when same is supported by staybolts is not considered as being part of the shell in computing its strength.

Longitudinal seams having the efficiencies of the shell courses are not required due to the rigidity and holding power of the stays reducing the hoop tension in the plate, and for this reason low efficiencies of wrapper sheet joints are not critical and double riveted lap joints are often used.

The A.S.M.E. Code for Power Boilers takes both the strength of the shell and the holding power of the stays into consideration in computing the allowable working pressure on curved wrapper sheets, (position *B*), Fig. 1, as follows:

P-212 (a). The maximum allowable working pressure for any curved stayed surface subject to internal pressure shall be obtained by the two following methods, and the minimum value obtained shall be used:

First, the maximum allowable pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays or riveted longitudinal joint or other construction. To this pressure there

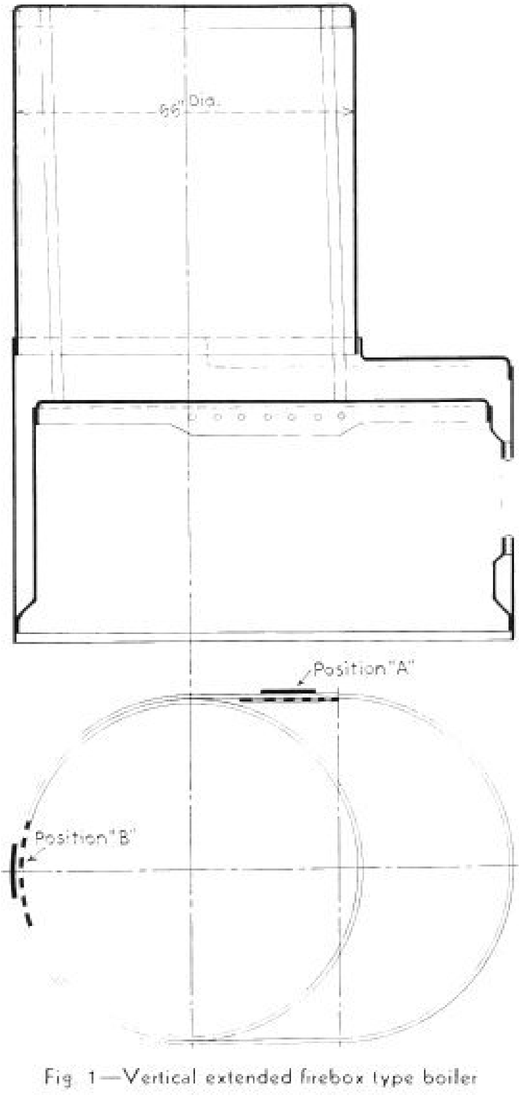

Fig. 1—Vertical extended firebox type boiler

shall be added the pressure secured by the formula for braced and stayed surfaces given in Par. P-199, using 70 for the value of *C*.

Second, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays or riveted longitudinal joint or other construction. To this pressure there shall be added the pressure corresponding to the strength of the stays or braces for the stresses given in Table P-8, each stay or brace being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay or brace.

P-199. The maximum allowable working pressure for various thicknesses of braced or stayed flat plates and those which by these Rules require staying as flat surfaces with braces or staybolts of uniform diameter symmetrically spaced, shall be calculated by the formula:

$$P = C \times \frac{T^2}{p^2}$$

where

P = maximum allowable working pressure, pounds per square inch.

T = thickness of plate in sixteenths of an inch.

p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, inches.

C = 112 for stays screwed through plates not over $\frac{7}{16}$ inch thick with ends riveted over.

C = 120 stays screwed through plates over $\frac{7}{16}$ inch thick with ends riveted over.

C = 135 for stays screwed through plates and fitted with single nuts outside of plate or with inside and outside nuts omitting washers. (See Par. P-203.)

C = 150 for stays with heads not less than 1.3 times the diameter of the stays, screwed through plates or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have a true bearing on the plate.

C = 175 for stays fitted with inside and outside nuts and outside washers where the diameter of washers is not less than $0.4p$ and thickness not less than T.

TABLE P-8. MAXIMUM ALLOWABLE STRESSES FOR STAYBOLTS AND STAYS OR BRACES

Description of staybolts and stays or braces	Stresses, pounds per square inch: For lengths between supports not exceeding 120 diameters	For lengths between supports exceeding 120 diameters[1]
(a) Unwelded or flexible staybolts less than twenty diameters[1] long, screwed through plates with ends riveted over	7,500	....
(b) Hollow steel staybolts less than twenty diameters long,[1] screwed through plates with ends riveted over	8,000	....
(c) Unwelded stays or braces and unwelded portions of welded stays or braces	9,500	8,500
(d) Steel through stays or braces exceeding $1\frac{1}{2}$ in. diameter	10,400	9,000
(e) Welded portions of stays or braces	6,000	6,000

[1] Diameters taken at body of stay or brace.

For flat stayed surfaces (Position *A*) Fig. 1, the allowable working pressure is based on the holding power of the stays as given in Paragraph P-199. The strength of the seam not being considered.

It is important, however, that when joint efficiencies are reduced due to using the holding power of the staybolts that care is taken that whenever such joints run beyond the staybolt area to change them at once to typical butt joints with both inside and outside straps, for without the assistance of the staybolts the joints would not be strong enough to hold the hoop tension of the cylindrical shell even under low pressures.

PAUL W. GREGORY has been appointed general manager of the Canton Culvert Company, Canton, O., subsidiary of Republic Steel Corporation, according to announcement by N. J. Clarke, vice-president in charge of sales of the parent organization. Mr. Gregory succeeds F. A. Kelly who was recently appointed president of the Toncan Culvert Manufacturers Association, Youngstown, O., and head of Republic's culvert division. For the past 15 years Mr. Gregory has been associated with the Wheeling Corrugating Company, division of Wheeling Steel Corporation, at Wheeling, W. Va. He was head of the culvert department of that firm.

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Vice-President—S. H. Barnum, The Bigelow Company, New Haven, Conn.

Secretary-Treasurer—A. C. Baker, 709 Rockefeller Building, Cleveland, Ohio.

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Office of Industrial Recovery Committee, 15 Park Row, New York

Manager—James D. Andrew.

Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President—Murrel J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

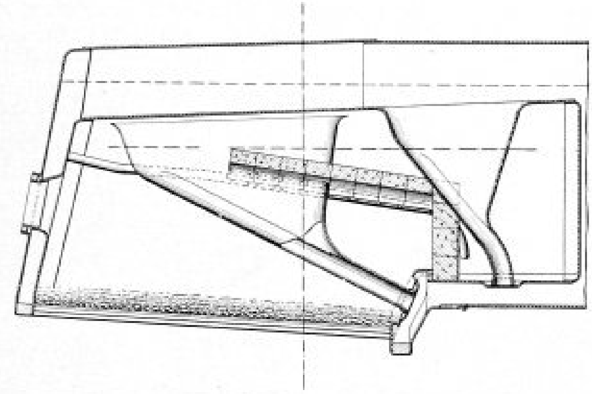
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

Selected Patents

Compiled by Dwight B. Galt, Patent Attorney, 1372-1376 National Press Building, Washington, D. C. Readers wishing copies of patents or any further information regarding any patent described, should correspond directly with Mr. Galt.

1,857,320. BAFFLE WALL. JOHN E. MUHLFELD, OF SCARSDALE, NEW YORK.

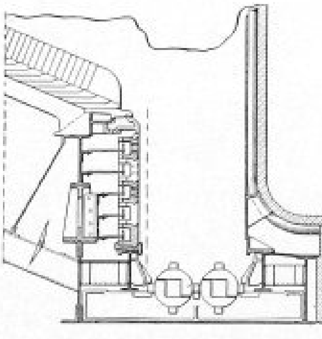
Claim.—In combination with a locomotive firebox having laterally spaced siphons therein opening through the crown sheet of the firebox and each provided with a lower obliquely inclined tubular extension opening through



the throat sheet, and arch tubes extending through the firebox between the siphons and the side walls of the firebox; a vertically positioned baffle wall in advance of the siphons, and a horizontally inclined arch wall abutting the upper end of said vertical wall extending rearwardly therefrom, said arch wall consisting of baffle brick supported upon the arch tubes and trunnions fixed to the siphons and the side walls of the firebox, and extending rearwardly between the siphons and the firebox walls at a point intermediate the upper and lower parts of the siphons to thereby expose a maximum area of the siphon to the direct action of flame and radiant heat from the fuel bed.

1,857,561. FURNACE WALL STRUCTURE. EDWIN LUNDGREN, OF FREDERICK, MARYLAND, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

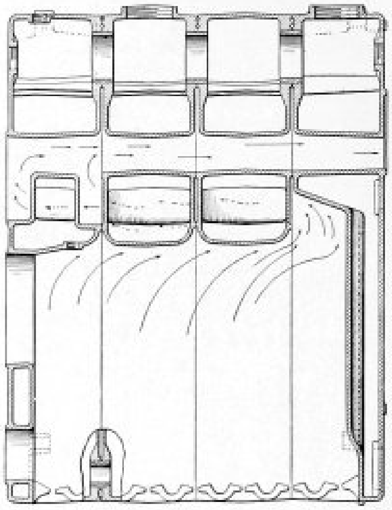
Claim.—In a multiple retort underfeed furnace having a relatively deep ash pocket with a clinker grinder arranged at the bottom thereof, the improvement which consists in the front wall of the ash pocket being made



up of blocks of refractory material arranged in superposed rows with the blocks of adjacent rows arranged in staggered relation, a metal wall structure spaced a distance in front of said front wall, and connections between said structure and said front wall for holding each block from fore and aft movement but permitting vertical and lateral movements thereof to allow for expansion and contraction of said wall. Six claims.

1,856,355. BOILER. CHARLES A. OLSON, OF GENEVA, ILLINOIS, ASSIGNOR TO CRANE CO., OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

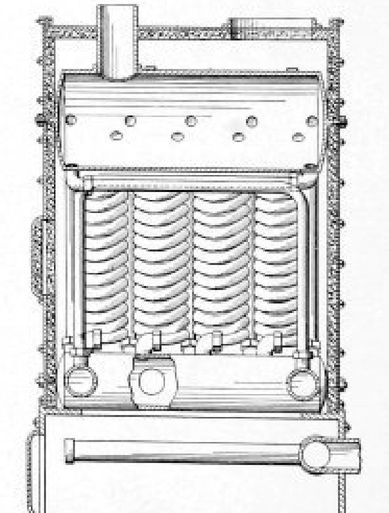
Claim.—In a boiler having a flue communicating with the fire box and extending generally horizontally, a water chamber comprising an upright water leg at one margin of the boiler fire box and a water passage joined to the top of said leg extending inwardly over the fire box having as its lower wall an inclined surface arranged to deflect the products of combustion from the fire box upwardly into said flue, said surface having its lowermost portion joined to the upper middle portion of the inner wall of said water leg on which lowermost portion the hottest of the products



of combustion strike as they are being deflected into said flue, said inclined surface being designed to rise inwardly, laterally and upwardly from its said lowermost portion, said arrangement of the inclined surface of said water passage and the connection of the latter with said water leg being adapted to aid a rapid flow of water over the most highly heated portion of said surface. Four claims.

1,858,156. HEATING FURNACE. NATHANIEL G. HOLLAND, OF NORFOLK, VIRGINIA, ASSIGNOR TO OLD DOMINION MARINE RAILWAY CORPORATION, OF NORFOLK, VIRGINIA, A CORPORATION OF VIRGINIA.

Claim.—A furnace construction, comprising a lower body assembly forming a fire chamber and having an upper ledge, a superposed housing having separable ends, front, back and top detachably connected with each other, the ends, front and back superimposed upon the lower body assembly, a



fluid circulating unit within the housing including lower spaced connected drums, an upper drum, tubes detachably connected with said drums for communication with each other, a plurality of coils detachably connected with the lower and upper drums and upwardly converging, baffles arranged on opposite sides of the upper drum and saddle straps bridging said upper drum and forming hangers for the baffles, studs on the ends of the drums and engaged in the front and back of the housing, and means engaging the studs exteriorly of the housing. Three claims.

Boiler Maker and Plate Fabricator

NRA
U.S.
CODE
GRAPHIC ARTS INDUSTRY

New Laying Out Series to Start Soon

In the course of the last year, a series of six articles on the subject, "Elementary Plate Layout," appeared in Boiler Maker and Plate Fabricator. In these articles the basic principles of laying out were explained and the three usual methods of development were demonstrated by example.

With a working knowledge of the three methods outlined, namely, the geometric or parallel line method, triangulation and the radial line method for conical-shaped objects, it is possible to work out developments for practically any shape or combination of shapes that may occur in the average run of industrial plate fabrication.

Proficiency in this trade, as in any other, comes only with long continued practice and application of the principles. In the short series mentioned, two typical examples were developed to illustrate each method. These were selected with the specific idea of suggesting to readers, interested in this work, the broad divisions into which plate layouts naturally fall. Almost innumerable shapes and combinations of shapes are possible.

With this thought in mind, Mr. Davies, the author of the original articles, is preparing for publication a second series to begin in an early issue, which in more advanced form will carry on the subject of plate layout. The basic idea in this case will be to apply the principles previously outlined to industrial shapes that require development in practically every plate fabricating shop.

Even in this more extended series but comparatively few examples are possible of complete explanation. To overcome this limitation the selection of shapes for development will be made to demonstrate the broadest possible application of the principles.

An innovation in the conduct of the series will be the inclusion in each issue of a practice example for interested readers to develop along the same lines as the layout explained. In the following issue the correct layout for this problem will be published. Those who carry out the actual layout will thus be enabled to check the accuracy of their work. Questions arising from difficulties in following the procedure outlined may then be referred to Mr. Davies for help in applying the principles involved.

A broad group of readers is directly engaged in laying out work—and still more are undoubtedly interested in acquiring a working knowledge of laying out methods. The series contemplated will be designed to be helpful to both groups. In addition, it is intended to provide a service available to all in which assistance may be obtained in the solution of problems giving trouble.

To this end it is desired that the facilities of the Questions and Answers Department conducted by Mr. Davies be utilized more widely than at present. It is available for the solution of all manner of problems, both layout and those pertaining to other questions concerning locomotive boilers, industrial steam generators and pressure vessel work. It is intended as a reader service and should be utilized. This department in conjunction with the series will provide complete facilities for study and explanation of layout problems.

While the subject matter of early articles of the series has largely been determined, in order to cover the field of plate fabrication broadly and in a manner to be of greatest interest to our readers, the author will welcome the suggestion of specific problems for solution. Such problems will be classified as to type and the general principles involved in each will be demonstrated by example and a complete explanation.

The series will be introduced by an explanation of the development of riveted pipe construction showing the method of laying out large diameter pipe bends and connections. Typical examples will be given in subsequent articles of breeching, oil tank, storage bin and hopper developments. As the series progresses, further subjects for development will be outlined.

As to the practical value that a knowledge of laying out may have, it is only necessary to consider the widening scope of the trade. Whereas a few years ago, only comparatively few fabricating shops specialized in large industrial shapes, today practically every heavy plate construction plant is equipped to carry out work of this character. New construction and replacements requiring fabricated shapes offer a potential demand in the future for a large volume of this work.

A study of the subject of laying out is worth while to those who may engage specifically in the layout trade and also to the many others who are engaged in executing the fabrication and assembly of such shapes as come from the layout bench.

Plans for Convention Delayed

While tentative plans are being made to hold a 1935 convention of the Master Boiler Makers' Association in Chicago in conjunction with meeting of several other railway mechanical associations, definite authority has not as yet been obtained from officers of the Association of American Railroads. Co-ordinating the meetings of the various groups of which there are at least seven or eight contemplated, so that there will be a minimum of interference between them, is a serious and involved undertaking for the committee of arrangements, especially since such a program has never before been attempted.

With the machinery set up for handling this situation, and with the supply association co-operating, the successful completion of arrangements may be expected. The only drawback at present is the general state of railway business. If improvement can be foreseen in the near future, there probably will be little question but that authority for the convention will be forthcoming. Before the next issue is published, it is hoped that a definite decision will have been reached and plans for the Master Boiler Makers' Association meeting can be settled.

D. & R. G. W. Locomotive 1409

BOILER EXPLOSION

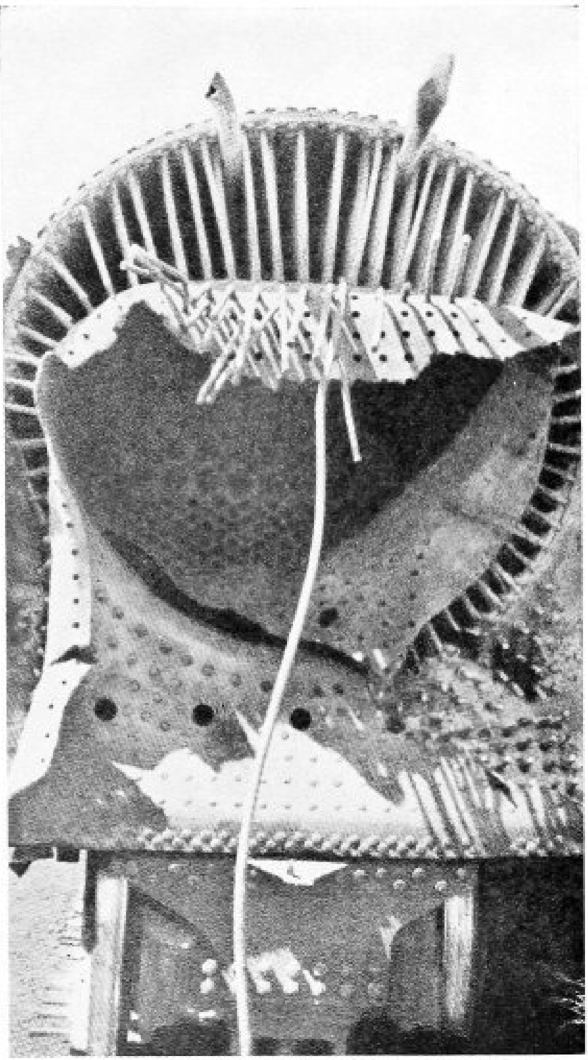


Fig. 1.—End view of boiler after explosion

On August 18, 1934, about 9:01 p.m., when about 1 mile west of Wellington, Utah, the boiler of Denver & Rio Grande Western Railroad locomotive 1409 exploded while the locomotive was hauling west bound freight train No. 61 at a speed estimated to be about 30 miles per hour. The engineer, fireman, and head brakeman were killed instantly.

The investigation of this accident has been made the subject of a report, which was recently released, by A. G. Pack, chief inspector, Bureau of Locomotive Inspection. This report which was submitted to the Interstate Commerce Commission in part is as follows:

Description of Accident

The locomotive and train departed from Grand Junction, Colo., at 2:03 p.m., August 18. Leaving Grand Junction the train consisted of 46 loads, 2 empties, and a caboose. Two additional loads were picked up at Thompson, 79 miles west of Grand Junction, making a total weight of train of 2258 adjusted tons from that point. The rating for this class of locomotive over the district where the accident occurred, which extends from Grand Junction, Colo., to Helper, Utah, is 3150 adjusted tons. Water was taken at Cisco, Green River, and Woodside, the last named place being approximately 34 miles east of the point of accident.

The back end or firebox section of the boiler was torn loose from the barrel by the force of the explosion and was blown 212 feet ahead of the point of accident and to the right of the roadway, the front end ring and door were blown 330 feet ahead and to the left, the left side of the cab was blown 337 feet to the rear and left, and other parts, including parts of the cab, the stoker, and the fire door were scattered over a radius of about 350 feet.

The 110-pound rails were kinked under the trailing truck wheels and deflected about 6 inches, the main frame extension over the trailing truck was broken at the main frame connection, the driving and trailing truck wheels were derailed to the right, and the tender, auxiliary water car, and first 10 cars of the train were derailed. The tender turned over and came to rest in reverse position on the right side of the roadbed. The locomotive running gear, together with the part of the boiler that remained attached to it, stopped 1432 feet ahead of the point of explosion.

Fig. 1 shows an end view of the boiler as it appeared after the back end was blown off; Fig. 2 shows a side view; Fig. 3 shows the back end standing approximately upright on the back head; and Fig. 4 shows a rear view of the back end including the back head.

Description of the Locomotive

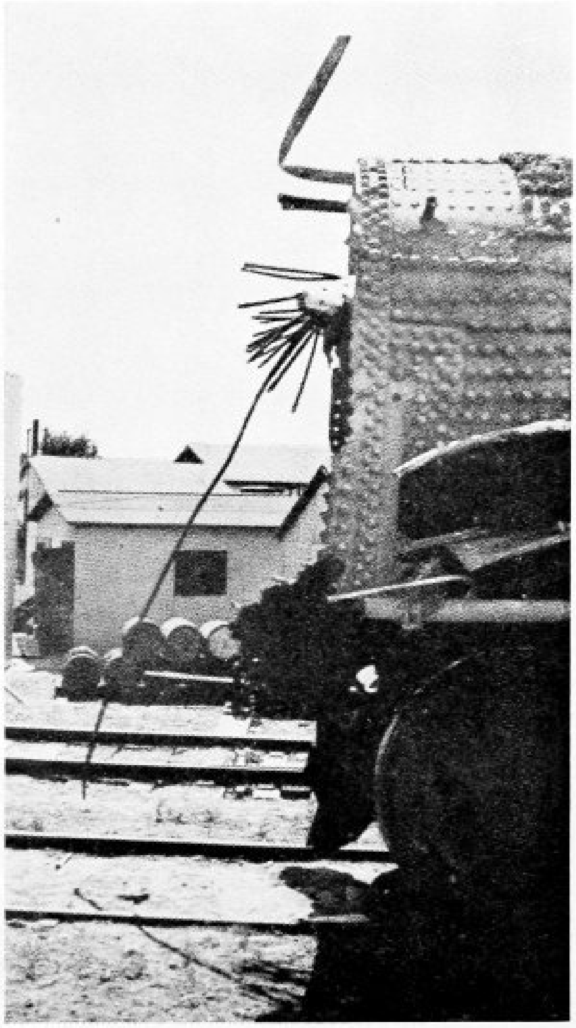
The locomotive was first placed in service in February, 1917. The wheel arrangement was 2-10-2, cylinders 31 inches bore and 32 inches stroke; driving wheel diameter 63 inches with new or full tires; tractive effort 81,200 pounds. The locomotive was equipped with a stoker, a feed-water heater, one feed-water pump, one injector of the inspirator type, and a superheater. Total weight of engine 428,500 pounds. The capacity of the Vanderbilt type tender was 20 tons of coal and 10,000 gallons of water and further water capacity was provided by a water car which was hauled behind the tender with a direct water connection thereto.

The boiler was of the extended wagon top type with wide radial stayed firebox and combustion chamber, designed for 200 pounds working steam pressure, and was equipped with three 3½-inch safety valves and two steam gages. The firebox was 132⅛ inches in length and 96¼ inches wide at the mud ring and was equipped with five 3½-inch arch tubes which supported a brick arch. The combustion chamber was 49½ inches in length.

All the firebox sheets were ⅜ inch in thickness except the inside throat sheet and the flue sheet which were ½ inch thick. The door sheet and flue sheet flanges were riveted, all other seams above the mud ring were fusion welded. The horizontal welded seams were located a vertical distance of 15 inches below the highest part of crown sheet.

The one-piece crown sheet had a slope of 6½ inches downward from the front of the combustion chamber to the rear of the firebox and was supported, on each side of the longitudinal center line, by six longitudinal rows of radial stays 1$\frac{1}{16}$ inches diameter in the body and 1⅜ inches at the crown sheet fit, with the crown sheet fit tapered 1½ inches to the foot, and by four rows of 1$\frac{1}{16}$-inch straight stays. The combustion chamber had a complete installation of flexible staybolts, the first four rows being expansion stays. The door sheet, both side sheets, and inside throat sheet were supported by 1-inch staybolts, all stays in the inside throat sheet and the two rows around the door sheet flange were flexible stays. All stays were spaced approximately 4 inches by 4 inches.

A water column was located on the right side of the back head of the boiler and one tubular water glass with three-faced shield and three gage cocks were mounted on the column. There was a tubular water glass with three-faced shield mounted on the left side of the back head with bottom connection in the back head and steam connection entering through the wrapper sheet ahead of the back head.



Examination of the Boiler and Appurtenances After the Explosion

The back end of the boiler, including the firebox section with the exception of a part of the inside throat sheet and combustion chamber were blown off the locomotive. The wrapper sheet, the roof of which was ⅝ inch thick, and the sides $\frac{9}{16}$ inch thick, was connected to the outside throat sheet and the boiler barrel by a double-riveted seam up to about the horizontal center line of the barrel of the boiler on each side. From these points the connection seam had three rows of holes with rivets in the two outside rows and rivets and radial

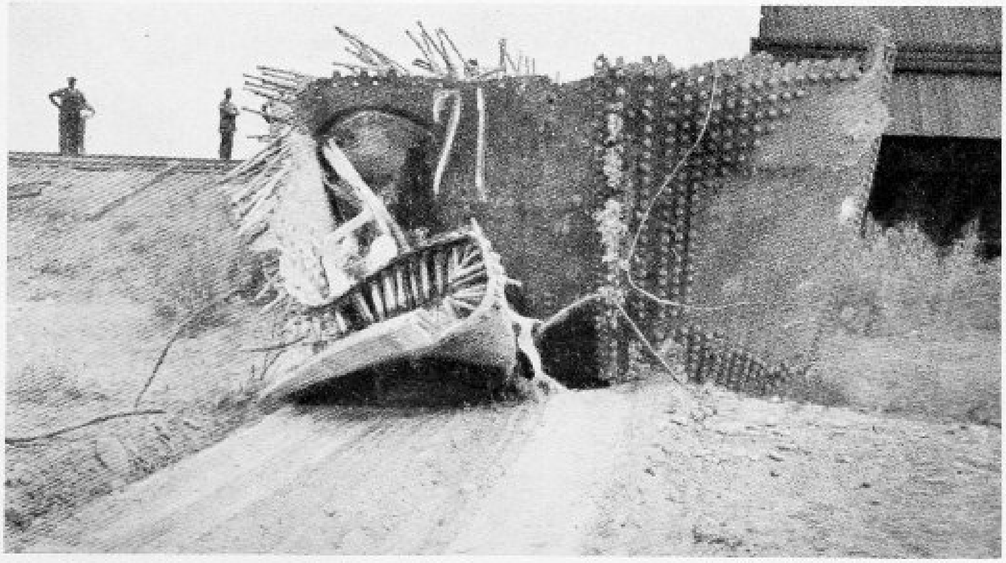


Fig. 2.—(Above) Side view after back end was blown off. Fig. 3. (Right) View of back end standing nearly upright on back head

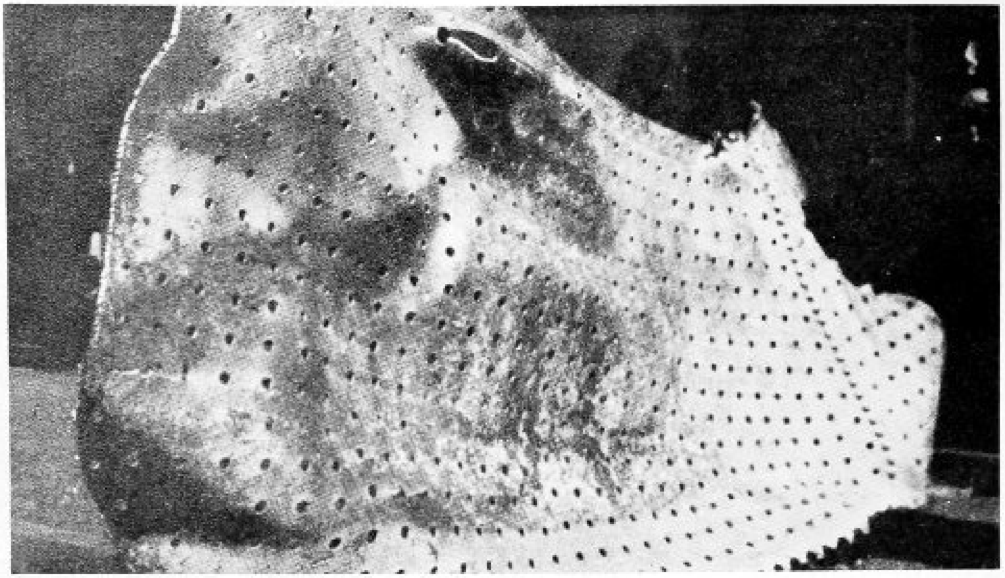


Fig. 4.—(Below) Rear view of back end, including back head. Fig. 5.—(Left) Water side of overheated left side sheet

stays in alternate holes in the center row. The wrapper sheet separated from the boiler by the breaking of the mud ring near both front corners and by shearing four mud ring rivets near the left front corner, shearing 10 bottom rivets in the connection seam on the left side, tearing of the sheet through five rivet holes, through fourteen flexible stay bushing holes in the first transverse row to the rear of the connection seam, and through twenty-nine connection seam rivet holes to the right side of the boiler. From this point the sheet failed through eight connection seam rivet holes, through eight flexible stay bushing holes in the first transverse row and six bushing holes in the second transverse row from front, thence diagonally to the rear and downward to the point of failure of the mud ring.

The right side of the wrapper sheet tore from the break near the right front corner of the mud ring diagonally to the rear and upward 24 inches to a staybolt hole six rows above the mud ring and ten rows from the front, then vertically a distance of 31 inches to a point about twelve rows of stays above the mud ring. The free end of the sheet was blown outward to approximately a right angle from the normal plane of the wrapper sheet. The wrapper sheet also failed along two lines near the left back corner, where the mud ring broke, one tear extended 13 inches forward through the sheet near the top of the mud ring; the other tear extended diagonally upward a distance of six staybolts to the back head seam where 25 rivets were sheared, from which point the flange of the back head tore upward for a distance of 44 inches.

The back and side sections of the mud ring were 6 inches wide and 4¼ inches thick and the front section was 7 inches wide and 4¾ inches thick. The front section was joined to the rear section at the sides near the front corners by welds which were so poorly made that they offered little resistance to failure, especially the weld on the left side where the parts were merely stuck together at the top and bottom edges. The break on the left side of the mud ring near the rear end was through solid metal; this break was apparently caused by the outward bending of the mud ring due to failure of the weld near the front end.

The firebox crown sheet tore from the door sheet through the fifth longitudinal row of crown stays left of the center line to the twelfth transverse row of crown stays forward of the door sheet, into and along the sixth row of crown stays to the left of the center line to the twenty-third transverse row, into and along the eighth row left of center into and across the twenty-fifth transverse row to the fourth longitudinal row to the right of center line, then ahead and through the twenty-sixth transverse row from the door sheet into the right horizontal side sheet welded seam. A portion of the left side of the sheet between the horizontal welded side sheet seam and the tear in the crown sheet extending forward to the twenty-seventh transverse row of stays ahead of door sheet was torn into five pieces and blown from the boiler. Between the twelfth and twenty-fifth rows of stays ahead of the door sheet, a section of the crown sheet, ranging from 8 to 16 inches in width, was closely rolled under against the fire side of the sheet.

The right side of the inside throat sheet separated from the fusion welded vertical seam at the side sheet and tore forward through the fusion welded horizontal seam in the combustion chamber a distance of 9 inches, then diagonally upward from the right front corner of the mud ring, a distance of 54 inches, through a number of staybolt holes and one arch tube hole, and folded up into the combustion chamber. The left side of the throat sheet separated from the fusion welded vertical seam at the side sheet and tore forward through the horizontal welded seam into the combustion chamber a distance of 4 inches and also tore a distance of 5 inches from the back edge about 18 inches above mud ring and bent inward toward the center line of the firebox.

The door sheet tore across the top flange through the riveted seam, sheared four rivets, and crushed at five rivet holes between a point 24 inches to the right of the center line and a point 18 inches to the left of the center line; from this last point the sheet tore irregularly downward through several staybolt holes, around 25 inches of the fusion-welded seam of left-stoker opening and through staybolt holes to the mud ring.

The right side sheet tore vertically through the entire height of the fusion-welded seam at the inside throat sheet (6 feet 7 inches), through the fusion-welded horizontal seam a distance of 24 inches, through the line of top mud ring rivet holes a distance of 28 inches, through the sheet near the top of the mud ring for a distance of 20 inches, then folded back against itself on the fire side.

The left side sheet tore through the full length of the horizontal fusion-welded seam, 9 feet 11 inches, through the entire length of the fusion-welded seam at the inner-throat sheet, 6 feet 7 inches, and through the top line of rivet holes at the mud ring and, with a piece of the riveted door sheet seam attached, was blown from the firebox.

The five arch tubes were pulled from the door sheet and inside throat sheet.

One back head brace was found to have an old fracture through about 33 percent of the cross-sectional area, and two back head brace lugs attached to the wrapper sheet had been broken for a considerable pe-

Fig. 6.—This is a view of the fire side of the left side sheet, showing the terrific force of the explosion

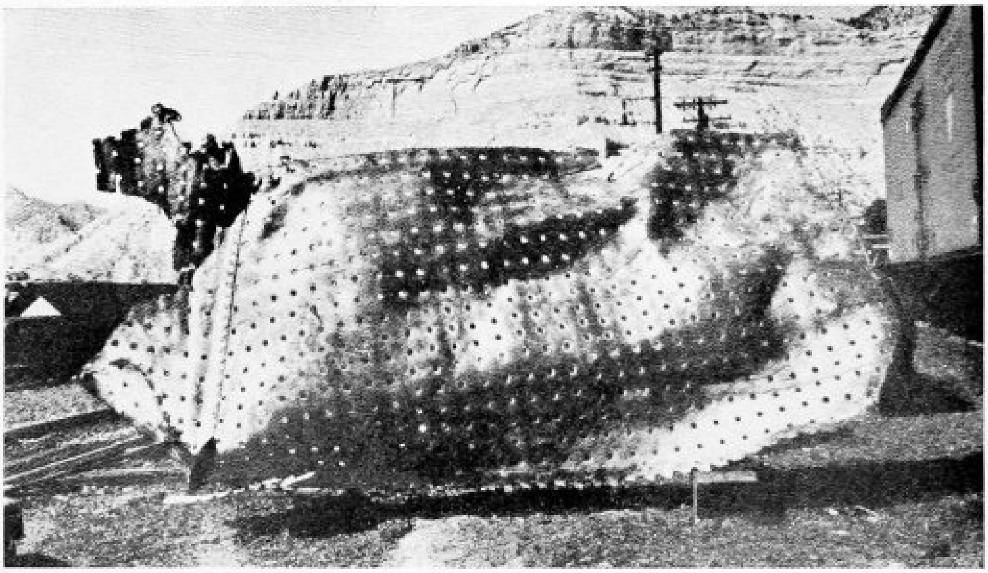
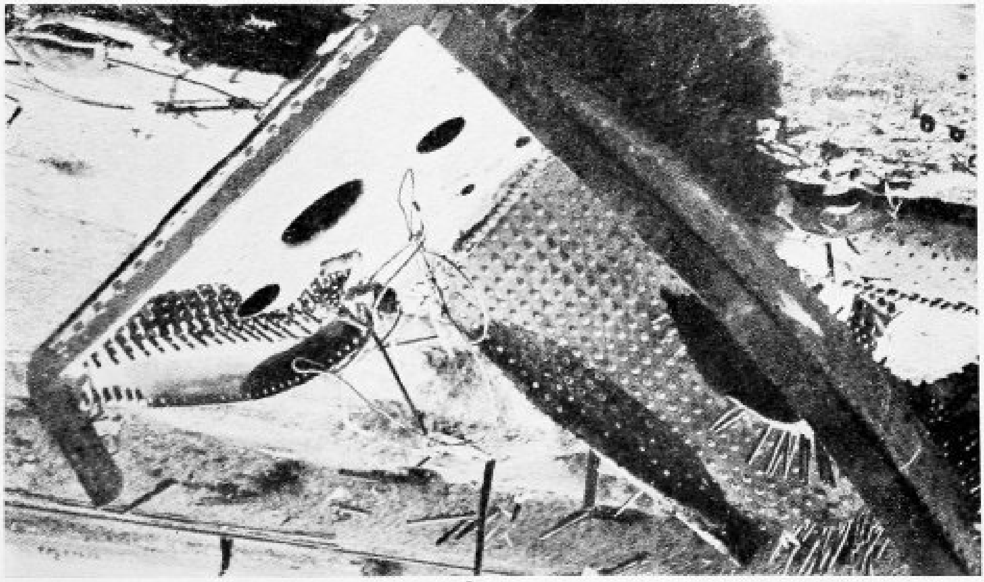


Fig. 7.—Inside view of the back end of the boiler, with the left side and part of the door sheet blown off



riod of time as evidenced by the position and condition. Seven staybolts were found to be badly corroded, 50 fractured, and 6 broken. These staybolts were in the short radius of the crown sheet.

The left side of the firebox, including the entire left side sheet above the second horizontal row of staybolts above the mud ring, to and including the third longitudinal row of crown stays to the left of the longitudinal center line of the crown sheet, was highly overheated. The five arch tubes, which had pulled from both door and throat sheets were overheated. Except for an irregularly shaped area embracing 44 staybolts in the right top corner, the entire door sheet above the fuel bed was overheated. A small area of the right side sheet under the brick arch was highly overheated; the remainder of this sheet, with the exception of a small area in the back bottom corner, was overheated to a lesser degree over the entire area above the fuel bed. The entire inside throat sheet above the fuel bed was slightly heated. The part of the crown sheet over the combustion chamber was slightly overheated between the first and eighth longitudinal rows of crown stays to the left of the center line of the crown sheet and the second and tenth transverse rows of crown stays rearwardly from the flue sheet; this overheating, however, was not sufficient to distort the sheet or spring the heads of the crown stays, nor to disturb the several patches of scale of about one-sixteenth inch thickness on the water side. The right side of the crown sheet and the area included from the longitudinal center line to the second longitudinal row of stays to the left of the center line showed no indication of overheating, there being no discoloration or distortion of the sheet nor loosening of the stays in the sheet. The heads of the staybolts in the highly overheated portions of the right and left side sheets were cupped when the sheets pulled off the bolts; the heads of the other staybolts and crown stays from which the sheets were pulled were sheared off and the threads of many stays sheared and remained in the holes.

Fig. 5 shows the water side of the overheated left side sheet with part of door sheet attached; Fig. 6 shows the fire side of the left side sheet; and Fig. 7 shows an inside view of the back end of the boiler with the left side and part of door sheet blown away and part of the crown sheet in place with stays intact.

The three safety valves were tested on another locomotive and were found to be in good condition; the first valve opened at 195 pounds, the second at 196 pounds, and the third at 200 pounds; the valves closed at 188 pounds, 192 pounds, and 194 pounds, respectively. The two steam gages were blown from the boiler and could not be found. The injector and feed-water pump intake and delivery connections were found free of obstruction and in good condition. The injector and the feed-water pump were tested on another locomotive and both worked satisfactorily. The water column and the left water glass assemblage were blown from the boiler and the parts were scattered about the wreckage; the openings into the boiler were found to be clear and the condition of the parts that were found indicated that these appurtenances were in good condition prior to the accident. The boiler was equipped with two 2-inch blow-off cocks, one in the throat sheet and one in the rear course of the barrel of the boiler; both cocks operated satisfactorily after the accident. Other than the presence of three paper wrappers, which apparently had contained anti-foaming boiler compound, the tender cistern was free from foreign matter and the return condensate separator showed no indication of oil leakage. One piece of wrapping paper was found lodged in a side cavity of a tank hose strainer but in such a position that it did not materially interfere with the flow of water. The other tank hose strainer was clear. Both tank hoses were crushed by the force of the explosion. The cistern of the auxiliary water car was clean.

Condition of Boiler Before the Accident

So far as the presence of any defects that may have had a bearing on the cause of the accident is concerned the boiler was in generally good mechanical condition before the accident.

The locomotive was turned out of Salt Lake City shop on July 19 after having received a class 4 repair. Reports show that a hydrostatic test was applied to the boiler and an interior examination made. Apparently the interior examination was not sufficiently thorough to discover the two broken back head brace lugs that were found after the accident and which had the appearance of having been broken for some considerable time, the fractured back head brace, and the corroded, fractured, and broken staybolts, some of which were undoubtedly in defective condition at that time.

The defective welds in the mud ring were made at the time the boiler was built and could not have been detected by usual inspection methods after the parts of the back end were assembled. Inasmuch as there was no record of any trouble ever having been experienced with these welds it can only be concluded that they were of sufficient strength to withstand the working pressure and other service stresses, but were not of sufficient strength to withstand the shock that occurred when the left side sheet was forced off the staybolts. The condition of the defective parts described did not have any bearing on the cause of the accident but it is apparent that the failure of the welds in the mud ring contributed to the violence of the explosion by facilitating the parting of the back end from the remaining part of the boiler following the failure of the left side sheet.

There was, however, nothing in the nature of the failure, or the failure of the related parts, that would indicate that any of the occupants of the cab may have escaped loss of life had the welds in the mud ring remained intact. The boiler was comparatively free from scale which was present on the firebox heating surfaces only in scattered patches varying from one thirty-second inch to one-sixteenth inch in thickness.

Daily inspection and repair reports were made out by various engineers who ran the locomotive from July 19, the last time the boiler was washed out.

Certain passages in the carrier's instructions covering blowing off and washing out of boilers show that extraordinary measures were taken to evade responsibility in the matter of washing out boilers as often as water conditions require. These passages follow:

> After boilers are blown, remove right and left front corner mud ring, inspect to see if the sludge is properly removed by the dry blow, and if there is any accumulation along the bottom of the mud ring this must be pulled out by the scraper. Under no circumstances must a nozzle or any water be used, as if this is done it will be construed as a washout, which would require all plugs being removed.
>
> Actual tests have shown that blowing down engine dry through using both blow-off cocks and refilling the boiler with fill up water is equivalent to a boiler wash.
>
> In each case where engine is washed make special report showing the necessity for washing the boiler.

With respect to the first quotation it is apparent that the presence of sludge on the mud ring is positive evidence that there are sludge deposits on other parts of the boiler, such as the crown sheet, upper parts of the flues, and bottom of the barrel of the boiler, because as the water recedes when the boiler is blown out some of the suspended matter will lodge on these parts. Other deposits of sludge are formed in areas of quiet or minimum circulation when the locomotive is not in operation by settlement of matter thrown out of solution by the action of heat in the boiler and by other precipitated suspended matter. These deposits may be present regardless of whether or not sludge deposits are found on the mud ring after the boiler is blown out; they often occur outside of the range of action of the blow-off cocks and consequently are not appreciably disturbed when the boiler is blown out.

Due to the circulation set up in the boiler, when it is refilled and used for generation of steam to move the locomotive and train, parts of these deposits are washed loose by the water and re-enter circulation in the form of suspended matter which contributes greatly to the tendency to foam, especially so when the dissolved solids in the boiler water consist principally of alkali salts, which is the prevailing condition in the district where locomotive 1409 was used. In view of known facts the statement in the second quotation that a complete blow down is equivalent to a boiler wash can be construed only as mere artifice.

The requirement contained in the third quotation that in each case where a boiler is washed a special report is to be made showing the necessity for washing the boiler is well calculated to discourage the person in charge at each engine house from washing any boilers because it is to his immediate interest to give the locomotives under his charge the minimum attention if he finds that it is the desire of his superior officers that he do so. In addition to this the men who are in direct charge of locomotives while at engine houses are usually fully occupied with their regular duties and are therefore not inclined to favor the making of special reports concerning phases of their work which may bring criticism upon them. Further, those in charge at engine houses, and engine-house employees, are not in a position to know anything about the performance of a boiler while on the line of road and are therefore not competent to decide as to whether the action of the water in the boiler while the locomotive was in use on the road was such as to indicate that boiler washing was, or was not, needed before the locomotive was started on another trip.

In the instant case the boiler was not washed in the interim between July 19 and the time of the accident on August 18, notwithstanding "Wash boiler" was reported nine times and "Change water" was reported twice by nine different engineers during this period. The foreman's notation on a report made on July 26 is typical of all the explanations:

Boiler wash not required by Rule 45 because engine given dry blow and water tested only 40 grains out.

There is no warrant for the use of any such expression as an explanation for not performing the reported work. Rule 45 reads:

Time of washing.—All boilers shall be thoroughly washed as often as water conditions require, but not less frequently than once each month. All boilers shall be considered as having been in continuous service between washouts unless the dates of the days that the boiler was out of service are properly certified on washout reports and the report of inspection.

The primary purpose of the rule is to require the removal of the sludge and scale forming matter that is deposited in the boiler, the concentrated boiler water, and the suspended matter, in order that the heating surfaces may not be endangered by sludge, scale, or other substances adhering to the surfaces and to avoid foaming troubles which are caused by concentration of soluble salts in the boiler water and/or the presence in the water of finely divided particles in the form of suspended matter.

A further reason for washing boilers as often as water conditions require, important, but secondary to safety, is the avoidance of the extravagant waste of fuel that accompanies use of locomotives after the water in the boilers has reached concentrations (including dissolved and suspended matter) where appreciable foaming occurs. The loss of heat in the blow-off water, the reduced efficiency of the boiler due to the condition of the water, the reduced efficiency of the superheater which then becomes merely an auxiliary or supplementary boiler and prevents the realization of the economy that would otherwise be obtained from superheated steam, increased friction and wear of the pistons and valves and related parts and loss of steam and power from such wear, and generally all around inferior performance of the locomotive, more than off-set any savings that can be made by neglect of proper boiler washing.

Blowing off the concentrated boiler water and diluting the contents of the boiler with fresh water and the use of antifoaming boiler compounds are recognized palliatives for the alleviation of foaming. However, after a period of use of a boiler, the duration of which is dependent upon the concentration of solubles and insolubles in the boiler water, the nature and proportion of such concentrates, and the design of and rate of working of the boiler, these palliatives cease to be of value. A "dry blow" under these conditions, while it may result in the locomotive being sent out after a hydrometer reading that has been predetermined as satisfactory, is not effective in enabling the locomotive to make any considerable mileage because foaming will again occur shortly due not only to such concentration of dissolved solids as may exist, but also to the presence of sludge that is stirred up by the active circulation in the boiler when the locomotive is working and thus becomes suspended matter. It is therefore necessary that boilers be washed not only to remove the dissolved solids in the boiler water but likewise to remove the suspended matter and precipitated suspended matter if accidents similar to the one that is the subject of this report are to be avoided.

All the persons whose duties required that they ride on the locomotive were killed instantly when the boiler exploded and it was therefore not possible to obtain any statements concerning the action of the water in the boiler during the trip. However, it is obvious that the overheating of the firebox sheets was caused by foul boiler water which was not in condition to absorb heat with sufficient rapidity to maintain the heating surfaces at a safe temperature. It is further evident that failure to wash the boiler as often as water conditions require was the primary cause of the accident.

Public Hearing on Boiler Manufacturing Industry Code Amendments

The National Industrial Recovery Board recently announced a public hearing will be held February 26, 1935, in Room A, of the Raleigh Hotel, Washington, D. C., on proposed amendments to the code of fair competition for the boiler manufacturing industry. Deputy Administrator Beverly S. King will conduct the hearing.

The amendments deal with the filing of price lists, liquidated damages plan for violations of the code, child labor, and safety and health of employees.

Work of the A. S. M. E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the code is requested to communicate with the Secretary of the Committee, 29 West 39th street, New York, N. Y.

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the council of The American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published.

Below are given records of the interpretations of this committee in Cases Nos. 746, 783, 784, 785, 786, 787, 790, 794, 795 and 796, they having been approved by the council. In accordance with established practice, names of inquirers have been omitted.

Case No. 746.—(Annulled)

Case No. 781.—(Reopened)
(Interpretation of Par. U-36)

Inquiry: In the application of the fifth section of Par. U-36 of the Code, should the required thickness of the head as determined by the head formula be used in determining the amount of reinforcement required, or should the required thickness of a shell as determined by Par. U-20 be used in fixing the amount of head reinforcement required?

Reply: It is the opinion of the Committee that the thickness to be used in applying the requirements of the fifth section of Par. U-36 shall be that of the shell when computed in accordance with the requirements of Par. U-20, using $E = 0.90$.

Case No. 783.—(Annulled)

Case No. 784
(Interpretation of Par. U-72)

Inquiry: May the excess thickness of the flange of a head be removed from the outside of the flange instead of from the inside as required by Fig. U-17 under the provisions of Par. U-72?

Reply: It is the opinion of the Committee that the removal of the excess thickness of plate from the outside instead of from the inside of the flange or the head as shown in Fig. U-17, will meet the intent of the requirements of Par. U-72.

Case No. 785
(Interpretation of Pars. U-120 to U-138)

Inquiry: May the recently promulgated Rules for Vessels Subjected to External Pressure be used to determine the wall thicknesses of tubes subjected to collapsing pressure and used in unfired pressure vessels, when such tubes are rolled into tube sheets and not otherwise supported?

Reply: It is the opinion of the Committee that the Rules for Vessels Subjected to External Pressure may not be applied to the determination of tube wall thicknesses. It is pointed out that these rules are limited in their application to the three general types of vessels shown in Fig. U-19.

Case No. 786.—(In the hands of the Committee)

Case No. 787.—(In the hands of the Committee)

Case No. 790
(Interpretation of Pars. P-108 and U-76)

Inquiry: When should the stress relieving operations required by Pars. P-108 or U-76 be carried out with relation to the making of the radiographs called for by Pars. P-102*i* or U-68*i*, where the plate thickness exceeds 4¼ inches?

Reply: It is the opinion of the Committee that when the plate thickness exceeds 4¼ inches, the joint should be stress relieved when the thickness of the metal deposited in the weld is 4¼ inches, before it is radiographed as required by Pars. P-102*i* or U-68*i*. Such joints shall also be again stress relieved after the completion of the welded joint.

Case No. 794
(Interpretation of Par. H-67)

Inquiry: Par. H-67 of the Code requires that each plate of a completed boiler shall bear the plate maker's name with brand and tensile strength. Is it necessary to transfer the plate maker's stamp to each and all of the small pieces of plate now used in many types of heating boiler construction?

Reply: In view of developments in the designs of heating boilers, it is the opinion of the Committee that it is not necessary to transfer the plate maker's stamp to each and all pieces of plate where the small size or shape makes it impracticable. The boiler manufacturer shall be prepared to furnish satisfactory evidence, when required, that all the plate used complies with Code specifications.

Case No. 795
(Special Case)

Inquiry: Is it permissible under the Code for Unfired Pressure Vessels to fabricate by fusion welding a dished head of semi-ellipsoidal form too large to be made from a single plate by welding together a dished circular center or crown plate and several "orange peel" or outer plates formed to the proper curvature?

Reply: It is the opinion of the Committee that this method of fabrication complies with the Code rules provided (*a*) the center of crown plate is not larger than 50 percent of the head diameter; (*b*) the several plates are carefully formed prior to welding so that the finished head will have the proper ellipsoidal form; (*c*) the plate surfaces are not thrown out of alinement as a result of warping due to the welding; and (*d*) the welding meets the requirements of the Code including those relating to joint efficiency and joint details.

Case No. 796
(Interpretation of Par. P-266)

Inquiry: Is it permissible to use for handhole openings in vertical firetube boilers under the requirements of Par. P-266 of the Code a special type of square thread plug which fits into the thimble or nipple that is in turn secured into the shell plate?

Reply: It is the opinion of the Committee that special square thread plugs as described may be used under Par. P-266 for handhole openings in vertical firetube boilers provided the requirements of Par. P-258 and P-268 are met, and the thimbles or nipples are so fastened that they cannot be removed in service.

Case No. 797.—*(In the hands of the Committee)*

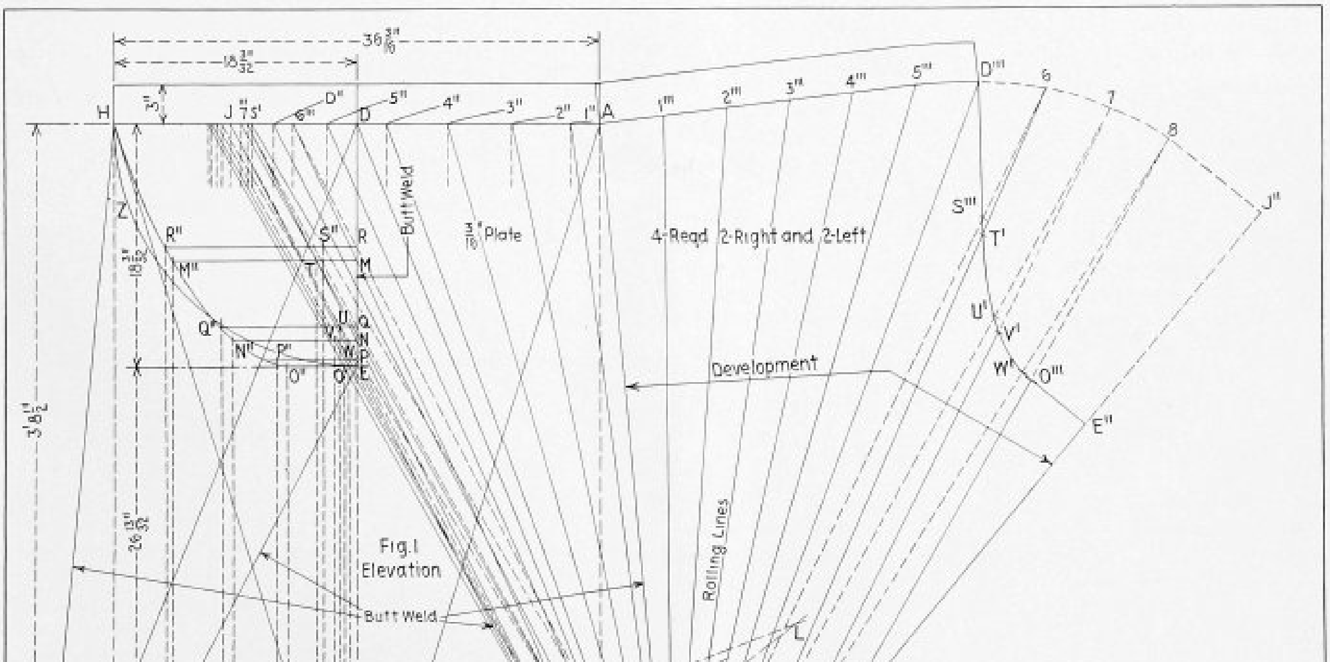
Method of Developing a Transition Piece in Four Plates

By I. J. Haddon

Fig. 1 represents the plan, elevation and development of a transition piece in four plates.

Draw the center line *D-D′* and the ground line *X-Y*, Fig. 1. Above the ground line lay out the elevation, and below set out the plan, as shown. Draw the line *D-C*, then *D-C-B-A* will be the elevation of a quarter of a scalene cone, and may be developed without drawing lines in the plan and elevation, but by obtaining the true lengths of the lines just as if they had been drawn. Divide *D′-C* into six equal parts as shown in *5-4-3-2-1* in the plan. Draw *D′-C′* and produce to meet the ground line in *G*. Then *G* will be the plan of the apex of the cone; produce *A-B* and *D-C* to meet in the point *G′*, which will be the elevation of the apex of the cone.

With *G* as center and radii *G-D′*, *G-5*, *G-4*, *G-3*, *G-2* and *G-1* draw arcs up to the ground line; transfer these points on to the line *H-A* as shown. Now from these new points draw lines towards the apex *G′* and meeting the ground line in *C″*, *5′*, *4′*, *3′*, *2′* and *1′*, as shown. Then these lines will be true lengths of the lines imagined to have been drawn from *D′ 5, 4*, etc., towards *G*. With *G′* as center and radii *G′-D″*, *G′-5″*, *G′-4″*, etc., draw arcs on to the development, as shown. Now with the dividers set to the distance equal to the curve *D′-5* in the plan, cut the arcs in *1‴*, *2‴*, *3‴*, etc., as shown. From these new points draw lines to the apex *G′*. From *G′* as center and radii *G′-1′*, *G′-2′*, *G′-3′*, etc., draw arcs to cut those lines already drawn as shown. A curve may now be drawn from *A* to *D‴*



Details of the plan, elevation and development of transition piece through $1'''$, $2'''$, etc., also from B to $C°$ through $1°$, $2°$, $3°$, etc., thus completing the development of the part D-C-B-A of the elevation.

Produce F-E to meet the line H-A in J. Drop a perpendicular from J on to the ground line in J'. Now the shape of the curve from J' to D' may be elliptical or any other desired shape, but for ease in fabricating and pleasing appearance of the completed transition piece I would design it as shown; therefore with D' as center and radius E'-J' cut the line E'-D' in K. Now with K as a center and radius K-D' draw the quadrant D'-8, join 8-J'. Divide D'-8 into three equal parts, draw 8-F and produce to meet the line D'-G produced, in L. Draw 7-$7'$ and 6-$6'$ both towards L, then F-C' will be divided into the same proportionate parts as the curve 8-D'.

This portion of the figure is another part of a scalene cone, and may be developed in a similar manner to the previous part developed, but, as it would necessitate alteration of the ground line and there is not room on my drawing paper for that, I would develop it by triangulation. Therefore, draw dotted lines from 6 to C', 7 to $6'$ and 8 to $7'$ to complete the plan. Drop perpendiculars from 6 and 7 to the line H-A in $6'''$ and $7'''$. Now drop perpendiculars from $6'$ and $7'$ to the ground line in $6''$ and $7''$. Join $6'''$ $6''$, cutting the line D-E in N. Points J' and 8 in the plan are both represented by J in the elevation. Join J-$7''$, $7'''$-$6''$ and $6'''$-C by dotted lines to represent those shown in the plan. These lines will cross D-E at P, Q and R respectively.

Obtaining the True Lengths

To obtain their true lengths: From C with radius C'-6 set off on the ground line the point S and transfer it to the line H-A in S'. Now draw S'-C dotted, crossing a line drawn parallel to H-D from R in S''; then S'-C will be the true length of C'-6, shown in the plan, and $6'''$-C shown in the elevation; S''-C will be the true length of C'-R' shown in the plan, and R-C shown in the elevation. Proceed in a similar manner to obtain the true lengths of the other lines.

To show the true face of D-E: From E' as center take off the distances E'-O, E'-P', E'-N', etc., on to the ground line and transfer them to their respective lines in the elevation, as shown in O''-P''-N''-Q''-M'' and R''. Draw a fair curve from H through M'', N'' and O'' and join O''-E by a straight line, as shown. This curve will be the true face of D-E. It will be noticed that the curve does not cross exactly on the points R'', Q'' and P''; that is on account of the points being on the diagonal lines (dotted lines) and shows the *actual* distance the lines are away from the transition piece. Now, although we treat triangulation as being all straight lines, these dotted lines are in reality *curved lines* when rolled to shape, but the difference in their lengths from the curved line is so slight that no notice need be taken of it.

Developing the Plates

To develop: From $C°$ as center and C-S' as a radius describe an arc; then with the dividers set to the distance equal to the length of the arc D'-6 and from D''', as a center, cut the arc in 6 as shown. Draw a dotted line from 6 to $C°$ as shown in the development. From $C°$ as a center and radius C-S'' cut the dotted line in S'''. Proceed in a similar manner to obtain the other points, as shown, to complete the development.

I may here remark that many persons at first thought would jump to the conclusion that, because D-E is the same length as D-A, the true face of D-E would be a semicircle and develop accordingly, but their development would be inaccurate. For instance, if we set out from E' on X-Y the semicircle representing F-B as shown in Y'-Y'' and draw lines to H and A, then H-Y', Y''-A would be a *side view* of the elevation of the transition piece, and the true face of D-E must lie inside of these lines, as shown, and not as shown by the quadrant Z. The only occasion when D-E can be a semicircle in a transition piece of this class, is when the diameters of the circles at the bottom of the legs, are the same diameter as the circle representing the top, and these legs must lie at an angle of 90 degrees and F-E must (if drawn) meet A as shown in Fig. 2.

Safety in Gas Welding and Cutting

Ever since the introduction of welding and cutting, manufacturers of equipment have constantly emphasized the importance of certain practices which should be observed in order that these processes can be used effectively. The result has been a splendid safety record among users of oxwelding and cutting.

For example, when portable oxy-acetylene welding and cutting outfits are taken out on the job for purposes of fabrication, maintenance, alteration or demolition, it is frequently necessary to use them in the vicinity of combustible material, and those in charge should realize the importance of observing special precautions under such conditions.

Special precautions are necessary (1) when welding or cutting in the vicinity of combustible material, to see that sparks or hot slag do not come in contact with the material and (2) when welding or cutting in places where flammable liquids or vapors may be present as in the vicinity of equipment for spraying lacquers and similar materials.

Whenever it is found that a job requiring welding or cutting is located near combustible material, first consider carefully the possibility of moving the part to a more suitable location. If this cannot be done, any material which might be ignited should be moved entirely away from the welding or cutting operation. This is particularly important when cutting is to be done. Combustible materials which cannot be moved should be protected by adequate sheet-metal guards or asbestos paper. Use water to dampen down wooden flooring. Cover any slowly combustible material with *damp* tarpaulin if there is a reasonable doubt about heat effect. *Dry* tarpaulin should not be used for this purpose.

Wherever there are floor openings or cracks in the flooring, it is also advisable to make certain that any combustible materials on the floor below are either moved away from the vicinity of the openings, or are adequately protected. Whenever possible, asbestos paper should be spread immediately under the welding or cutting work to prevent sparks from falling through the cracks in the floor.

The cylinders of oxygen and acetylene should, of course, be placed at an adequate distance from the work, particularly when welding or cutting is done overhead.

When it does become necessary to use oxy-acetylene equipment near wooden construction or in locations where combustible material cannot be removed, water hose, chemical extinguishers or fire pails should be located where they can be used quickly.

If work is being carried out in a building equipped with sprinkler protection, it should be the duty of the foreman or other authority to determine that the sprinkler in the location of the job is in good operating order and has not been turned off for repairs or any other reason.

Plants in which flammable liquids or vapors are used, as in paint or lacquer spraying or dipping equipment, might well adopt the policy established by many large plants in the chemical and petroleum industries. In these plants, sections in which flammable gases, vapors or liquids are present, are designated as restricted areas. No work of any kind involving a possible source of ignition may be done within these restricted areas without a permit signed by certain designated authorities, such as the general superintendent. Such a permit is not issued until those in charge have inspected the premises and determined, preferably by means of a combustible gas indicator, that it is safe to do hot work.

In rooms containing flammable vapors or liquids, lint, dust, or any loose combustible stock, cutting or welding should be used only after making a thorough inspection and ventilating the room and, finally, testing the atmosphere. All tanks and other containers with tight covers should be thoroughly drained, ventilated to remove vapors, and either filled with water, or inert gas, or thoroughly cleaned out by steaming or by the use of an approved cleaning material. Where there are dip tanks or other containers near work that has to be done, if they cannot be thoroughly drained, ventilated and cleaned, they should be provided with absolutely tight covers and the welding or cutting operation should be carried out in such a way that they are thoroughly protected from having any sparks fall on or near them. The apparatus should not be used just outside dipping or spraying rooms, unless there is no possibility of sparks or vapors passing through broken windows, open doorways, and cracks or holes in walls or floors.

An obvious precaution is that equipment should be in good order. Good hose, with connections tight and threads in good condition and modern apparatus listed as standard by fire underwriters' laboratories should be used. Furthermore, this apparatus should be inspected at regular intervals to insure its being in good order.

The oxygen and acetylene cylinders should be mounted securely on a truck or otherwise arranged so that they can not be knocked over.

Extra cylinders of oxygen and acetylene should be stored outside areas in which work of the type discussed in this article is being done.

Those in authority should realize the importance of these precautions and should make certain that they are observed by those in their employ.

The oxy-acetylene flame is to be considered as any other flame or electric arc. There are certain places where no flame should be lighted, there are others where special precautions should be taken before lighting a flame or heating the work, but in general the oxy-acetylene process may be used without fear if an open flame is justified.—*Oxy-Acetylene Tips.*

Recent Developments in Boiler Design

By G. P. Blackall

Several novel types of steam generator were announced in Europe during the past year. One of these, of German origin, depends on the use of a steam boiler revolving at several thousand revolutions per minute instead of remaining stationary. It is formed of a series of bent tubes of "U" shape, each constituting an independent miniature steam generator. The boiler, which is heated externally by burners, also rotates on the outside of the turbine, which runs in the opposite direction at about 10,000 to 12,000 revolutions per minute—four times the speed of the generator.

Another new boiler operating on the single tube principle was also announced during 1934. It employs a continuous welded tube of great length in which the feed water, during its travel, is successively pre-heated, evaporated to steam and superheated. The water passes through the entire circuit, which may be nearly 5000 feet in length, at an extremely high velocity to improve the rate of heat transmission and prevent troubles caused by steam bubbles, which under these conditions it is claimed cannot adhere to the inside of the tube.

Valuable data were made public in connection with the generation of steam under critical conditions (3200 pounds per square inch pressure and 706 degrees F. temperature), using pure water. It seems to have been proved that steam can be generated without difficulty in narrow-bore steel tubes under pressure conditions that do not approach the actual critical stage, providing the water is absolutely pure. Existing steam generating plants operating under the critical conditions have therefore now been adapted to operate on sub-critical principles, and apparently almost any desired pressure can now be used, say from 1000 to 3000 pounds per square inch.

It is proposed to construct self-contained units of turbine and steam boiler, and to meet the variations in the power demand by increasing or decreasing automatically the steam pressure in the generator within the above-mentioned wide range. However, the older principle may still be used of operating at 3200 pounds, with superheating to 850-900 degrees F., and reduction of the pressure to any desired figure, with reheating of the steam before passing to the turbine.

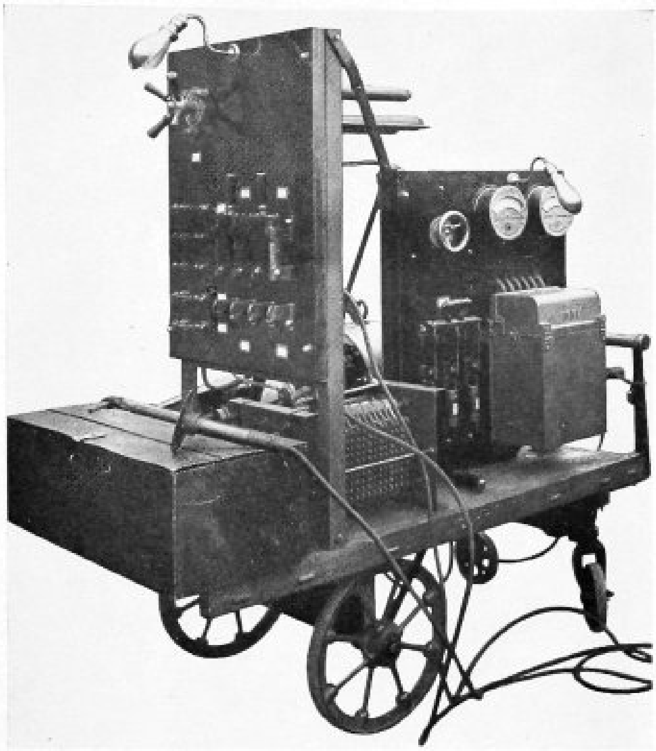
Considerable attention was paid during 1934 to the results obtained with a special type of tubular boiler in which the flames and hot gases used for heating the tubes are caused to travel at very high velocity to increase the rate of heat transmission, using special fans. In addition, the combustion chamber is under pressure, and operates almost on the principle of the internal combustion engine, with actual explosion of the oil generally used as fuel. Alternatively, a constant pressure in the combustion chamber of 35 pounds per square inch can be employed, so that pulverized coal may be utilized in addition to gas or oil.

Notable progress has lately been made with the principle of generating steam by passing highly superheated steam into water in the boiler drum so that the heat is transmitted from the furnace setting to superheater coils only, and not to the drums. By this principle the use of forged steel under super-pressure conditions is avoided.

A further number of small mechanical stokers appeared on the British market for vertical boilers, hot water heating boilers, and similar applications. With about a dozen makes now in the field competition will evidently be keen in the near future.

Boiler Manufacturing Industry Submits Proposed Standard Forms

The National Industrial Recovery Board has announced that suggestions or objections concerning the proposed standard forms of contract proposal and boiler performance and regulations for performance predictions, submitted for approval by the industry Code Authority, must be filed with Deputy Administrator Beverly S. King, Room 3076, Department of Commerce Building, Washington, D. C., before February 19, 1935.



Arc welder of the 1914 variety

A Brief Review of Developments in

ARC WELDING

By A. F. Davis*

Even though welding, as we know it today, has developed practically within the last ten years, it has been used in some form by man almost since the discovery of metal. No definite date can be assigned to man's first joining of metals, for the simple reason that the date of the discovery of iron is problematical.

We find mention of iron in the Bible, fourth Chapter of Genesis, believed to have been written by Moses about the 13th Century, B.C. There are evidences that iron was known in 5000 B.C. A wedge made of wrought iron was found in the great pyramid of Gizeh.

Since iron exists very rarely in the pure state, man's first production of it must have come about by accident. The generally accepted theory is that in converting wood to charcoal, a lump of iron ore found its way into the fire and in the presence of a strong draft of air, the first iron was produced. Iron in the completely fused state was unknown in ancient civilization. It was not until the 14th Century A.D. that cast iron was discovered.

Even though welding and the metal iron are known to have been in use practically since man's earliest existence, there are few specimens of the early welder's art. The reason for this is to be found in the very nature of the metal welded—inability to resist the effects of corrosion. The 16-inch diameter by 22-foot high column at Delhi is composed of *welded sections*. However, the metal iron and use of welding were known thousands of years before this column was erected.

Cast iron is said to have been produced in 1350. Malleable iron was discovered about the year 1722 and the first rolling mill built in 1784.

Steel Discovered 1000 B.C.?

Steel is mentioned in the second book of Samuel purported to have been written about 1000 B.C. Steel was regarded as a very valuable metal in early times. Alexander the Great in about the year 330 B.C. was presented with 40 pounds of Indian steel. The first steel is supposed to have been produced by the accidental presence of low-carbon malleable iron in a bed of hot charcoal.

Crude methods of producing iron and steel continued up to the middle ages. It was not until the middle of the last century that any real impetus was given to production of these metals. The introduction of the Bessemer-Kelly process of making low-carbon steel was the first really significant advance. This process, followed shortly by the Siemans-Martin open-hearth process, paved the way for what is now being called "the steel age."

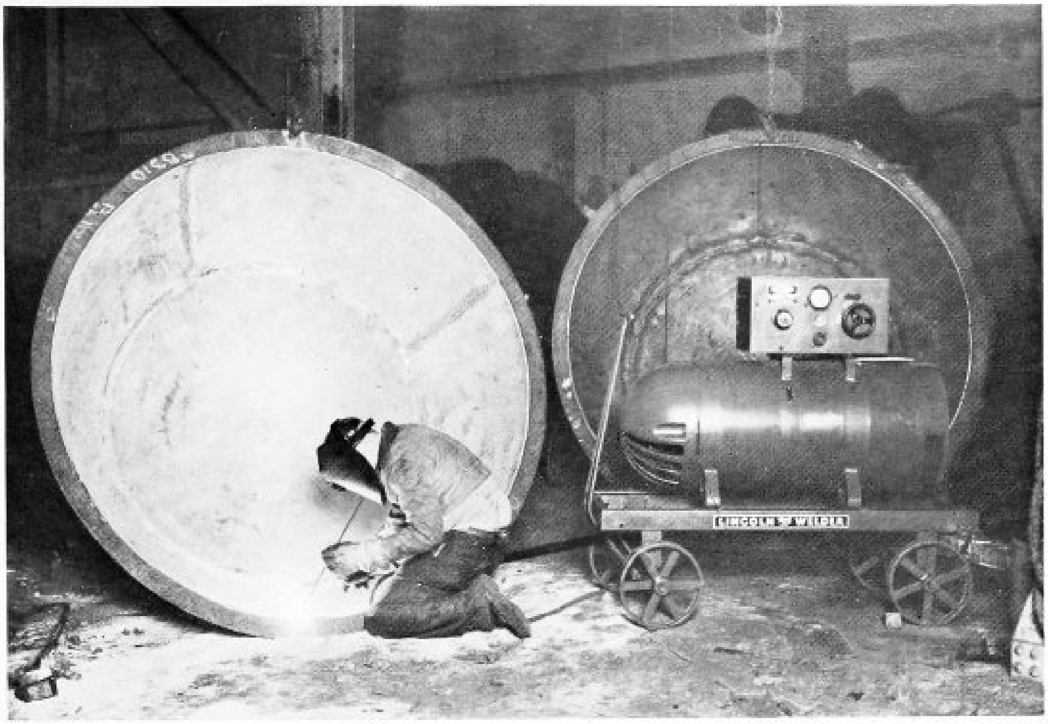
Welding at this time had made little or no progress. The same method—forge welding—that had been employed from earliest times, could not be used effectively in coping with the wide variety of problems incidental to the increased use of steel. Many new processes were discovered but were slow in developing.

The first real advance in the art of joining metals came about with the introduction of the electric arc into welding.

In 1907 J. F. Lincoln was calling on the Cleveland Steel Castings Company officials shortly after he joined the company which now bears his name. In the course of a general conversation on electrical equipment one of the steel castings men remarked that the fellow who would produce some device through which satisfactory repairs could be made on broken castings would be doing something for the steel castings business. Electric welding was known then, but it was hardly out of the experimental stage. Mr. Lincoln went back to the plant and the engineers went to work to make a welding apparatus for those broken steel castings.

The device which resulted worked, although it could not be called highly successful. One great defect was

* Vice-president, The Lincoln Electric Company, Cleveland.



In appearance and efficiency this 1935 arc welding machine is a far cry from the 1914 type

the loss of current. When the Lincoln engineers got through, a new application of electrical principles had been worked out and patented, in which the voltage decreased as the current increased, making it possible to control the current used in the arc needed for successful electric welding. This principle is used in one form or another by every process of arc welding. The Lincoln Electric Company's "stable arc" welder was the first in the field.

Production of this stable arc wrote the first chapter in the history of an art which in recent years is coming to be recognized as a most important industrial development—the science of electric welding.

In 1909 the first redesign of cast iron in favor of pressed steel was noted as Lincoln engineers took a compensator can and lightened its weight and design.

In 1916 use was first made of arc welding in place of riveting on structural steel when a factory building was remodeled. It was almost a decade before the first 100 percent rivetless building was built.

The year 1917 marked the opening of the first welding school by The Lincoln Electric Company.

The early adventures in welding, sponsored mainly by the manufacturers of arc welding equipment, aroused considerable controversy. Stand-patters freely announced that it was no better than soldering, and that anyone who utilized the process was risking his neck, reputation and eyesight.

The World War saw many new uses of arc welding, especially in shipyards. The year 1919 proved to be an important year. The first motor to be completely redesigned from cast iron to arc welded steel came out.

In 1925 the process had attained wide acceptance. In fact, there was such great demand for it that an extreme shortage of competent operators was noted. To meet this demand, welding schools increased their enrollment.

In this same year the first of the petroleum transmission lines was arc welded.

The year 1929 marked the practical innovation of the shielded arc and a new era in electric welding. Welding engineering suddenly became a specialized field. The shielded arc ended all arguments as to the safety of welds and the economy of welding.

Prior to this time, the welding machines were either of the alternating-current transformer type or at most, crude forerunners of the types of welding generators in use today.

Electrodes used in the early days were nothing more than rods of mild steel. Soon, however, it was discovered that welding was simplified and results improved if the electrodes were covered with a light coating or wash. These light coated rods, the "bare" or "washed" electrodes are still in quite general use, although they are rapidly being replaced by heavily coated "shielded arc" rods.

Limitations of the bare or lightly coated electrode are well known in welding circles. A tensile strength of about 58,000 pounds is the limit of welds produced by them. The ductility and elongation of welds made with them are limited. The shortcomings of welding with bare or slightly washed electrodes are due to the fact that, the arc being exposed to the ambient atmosphere, the molten electrode metal attracts oxygen and nitrogen from the air forming oxides and nitrides, which produce a porous condition greatly weakening the welds. This fact has been recognized by chemists and metallurgists everywhere.

As a result of this a great variety of electrode coatings have come on the market based entirely on the universally accepted theory that the coating as it burns shields the arc from the atmosphere. These shielded arc electrodes are used not only for welding mild steel, but for cast iron, various steel alloys, and non-ferrous metals.

As far back as 1914 arc welding had proved itself as the most economical method of repairing worn and broken equipment. But the 1935 welder is as far ahead of its 1914 predecessor in efficiency as in appearance. On the next page is a table comparing the characteristics of welds of these two periods:

	1914	1935
Tensile strength (pounds per square inch)	40,000	65,000 to 75,000
Ductility (percent elongation in two inches)	5-10	20-30
Fatigue resistance (pounds per square inch)	12,000	30,000
Impact resistance (foot pounds Izod)	8-15	50-80
Density (grams per cubic centimeter)	7.5	7.86
Corrosion resistance	Less than mild steel	More than mild steel
Speed of welding	100%	150-300%

The reason for the marked superiority of welds produced today over those produced formerly is to be found in the improved design and characteristics of the modern welding machine and electrodes.

Today there is hardly a metal working industry which does not utilize arc welders. It is used in joining the thinnest of sheets in sheet metal shops, in joining 4- and 5-inch plates for battleships; in aeroplane construction; in mines, quarries and gravel plants; in constructing pipe lines, tanks and reservoirs; on boilers and pressure vessels—in fact, in every conceivable industry. Only recently a Chicago hotel purchased an arc welder for use in building maintenance.

Suggestions for Avoiding Accidents

A storeroom clerk tried to repair a pair of goggles. Instead of providing the proper lens, he put a cover glass, intended only as a protection to a welding lens, into the goggles. This pair of goggles went to a workman, who suffered a severe eye injury when a flying object struck this fragile piece of glass.

This was one of the accidents called to the attention of members of the Metals Section of the National Safety Council during 1934, with the hope that suggestions might be made and remedies applied. In this particular instance, it was pointed out, goggle repairs should be made under the direction of a competent person.

In another instance, a man wheeling lime in a barrow was wearing goggles in keeping with the plant rule, when the screw cap holding the lens in place, worked loose and dropped out, allowing the lens to fall out, and permitting blowing lime to enter his eye. While his injury was slight, it was recommended that the supervisory force should occasionally check on men wearing goggles of the screw cap type in order to see that they keep the caps screwed tightly.

A workman was oiling cables and sheaves of a coke oven back platform mud elevator. The elevator was started suddenly. It reached the top of the slide, and before the limit switch could function, the oiler's head was caught between the shield on the elevator and the cross bar of the slide, and he was fatally injured. It is believed that this workman was watching the operation of the sheave below and had placed himself in such a position that his head extended over the shield at the back of the elevator, and directly in line with the top shield and cross bar at the top of the elevator slide. While he had been instructed to lock the electrical control switch and had been provided with a lock, the lock was found on the platform after the accident. As an additional precaution, the entire back side of the elevator has been screened.

Another 1934 accident in the industry brought about a change in working practices in at least one plant. A switchman was stationed two car lengths below track scales to throw the knuckles over after cars were weighed. A car hung up on the scale. The switchman thought it had cleared the scale and went between cars to throw the knuckle over, while at the same time another switchman—the one at the scale—gave the locomotive engineer the signal to shove the car clear of the scale. The man's hand was caught between the couplers. It was necessary to amputate the hand above the wrist. It was recommended that the practice of throwing knuckles until all the cars on the string have been weighed should be discontinued. Instead, couplings should be made after weighing, on a signal to the engine crew.

A pipe welder and his helper were working on triple length 16-inch outside diameter pipe. The weld had been made when a 10-foot length was rolled onto the welding jacks. This new piece to be welded was out of round with the pipe to be welded and the crane was busy, so the pipe was rolled from the jack to the skids, a drop of 4 inches. During the process the welder called to his helper, asking if the pipe would reach the skid. The helper said it would. The pipe was rolled from the jack, but was too short for the skid, the end falling on the inside of the skid and catching the helper's hand between the pipe and the skid. Two fingers were badly mashed. To prevent a recurrence of this accident, the skid was moved in 2 feet to take care of short lengths.

A machinist stepped up on a tin pot to remove cobbled sheet from a flux box. Two pigs of metal had been placed in the pot and another was placed at the edge of the pot to warm up. The plate used to cover the opening between the pot and the roll feeder was not in place at the time and the man stepped into hot metal. He suffered second and third degree burns of the right foot. He was disabled three or four months. Until such time as a different type guard could be devised, it was decided that a man will station himself at the pot until the pig metal has melted down in order that the plate cover can be placed.

Another of the 1934 accidents demonstrates the importance of refraining from running pipe lines too close to ladder rungs.

A man was descending a ladder into a hopper pit. This ladder consisted of rungs embedded in concrete in such a way that they extended 7 inches from the wall and were 15 inches wide. A steam coil extended along the wall and back of the ladder at a point 45 inches above the floor of the pit. This coil was close enough to the ladder to be used as a foot rest in ascent and descent, and it showed wear, which indicated that it had been used in such a manner. In this case, the man's foot slipped on the coil and he fell. He suffered a fracture of the hip and was off the job several months.

Apparently the following accident was caused by an explosion of hydrogen which had accumulated in a tank car. The hydrogen may have been generated by the action of the sulphuric acid on the steel body of the tank. The tank car in question had a 24-inch opening in the top, which was fitted with a lid having two holes in it. The lid was held in place by a bolt, but presented an opening for a pumping hose when turned.

A pipe fitter and helper had made two pumpings of waste sulphuric acid solution from this tank car on two consecutive nights. On this night, they were preparing to make a third pumping.

The helper went on the tank with an open light, apparently to see whether there was sufficient space to make the pumping. He set the flambeau down on the tank car, slid the lid around, and as he reached for the flambeau, there was an explosion. He was thrown off the car. He died almost immediately.

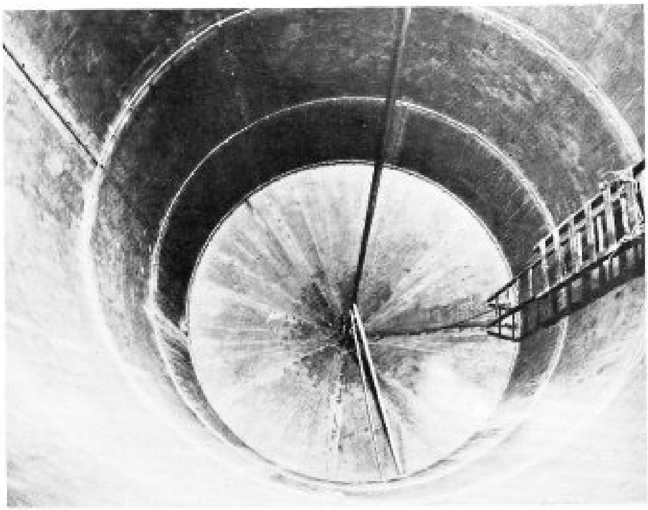
The Metals Section, after reviewing this accident, recommended that the use of any light except a storage battery hand lamp or approved electric torch must be prohibited in the operation just described.

Nickel-Clad Steel Used for Huge Soap Kettle

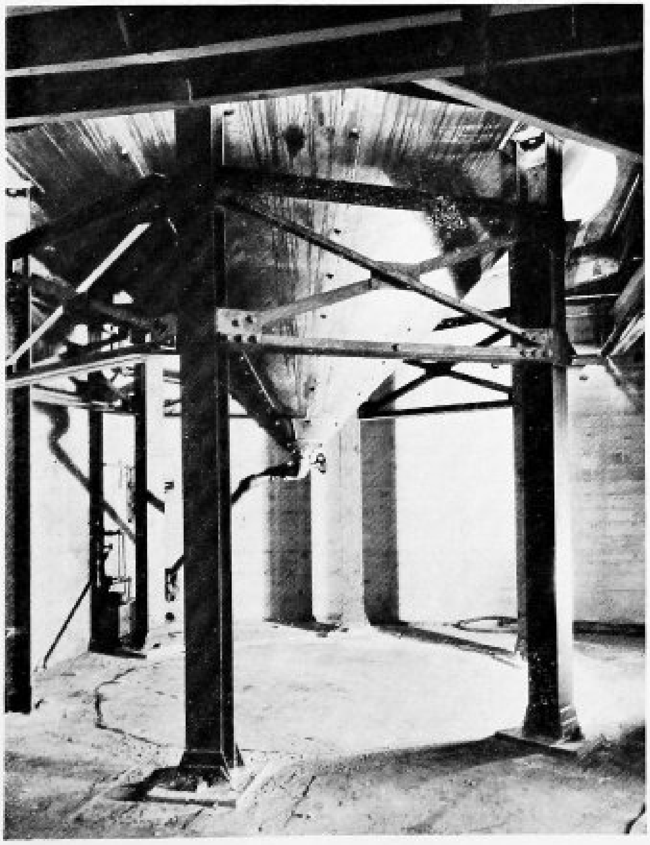
The Southwest Welding and Manufacturing Company, Alhambra, Cal., recently completed one of the largest soap boiling kettles which has yet been constructed entirely from nickel-clad steel, for a large soap manufacturer on the Pacific Coast. The kettle, composed of four courses between its butterfly cover and conical bottom, is 15 feet in diameter. The straight portion, from the top of the kettle to the top of the cone is 22 feet in height. The cone is 7 feet high on the vertical, making a total height for the kettle of 29 feet.

The cone was made from plates 3/8-inch thick, while the bottom vertical course plates are 5/16 inch thick; the second and third course plates are 1/4 inch thick, and the fourth or top course plates were 3/16 inch thick. Welding throughout was done with Inco metallic arc welding wire No. 31, using the arc-welding process. All of the plates were clad with pure, solid nickel on one side to the extent of 10 percent of the total plate thickness, with black oxide finish on the nickel surface. The heating coils and the discharge spout are pure, solid nickel piping.

In the processing of fine soaps in this kettle, the fluid mixture will come in contact only with the pure nickel surface of the nickel-clad steel or the piping. This pure nickel surface is immune to rust and corrosion frequently met in ordinary steel kettles particularly at and above the liquid-air level, which conditions cause costly contamination and discoloration of the product and shorten equipment life.



Inside view of nickel-clad steel vessel



Bottom of giant soap kettle

Nickel-clad steel is a joint development of The International Nickel Company, New York and Lukens Steel Company Coatesville, Pa. The material is produced by the hot rolling and bending of a light layer of pure, solid nickel and a heavier layer of steel. The nickel layer can be any desired proportion of the total plate thickness, from 10 percent up. The bond of the nickel layer to the steel base is obtained through thermal diffusion which forms a solid solution alloy at the interface, and there is no separation of the layers under normal conditions of temperature changes, pressure, vacuum, or mechanical shock. The material can be sheared, bent, flanged, welded, or riveted without cracking or peeling, and is finding application not only in soap boiling kettles and crutchers, but also in storage tanks, hoppers, cooling forms, amalgamators, caustic soda tanks and other soap-making equipment.

Putting Native Ingenuity To Work

A welding operator's ingenuity is many times the means of bringing a vast amount of additional business into the welding shop. Sometimes this results from the successful accomplishment of a difficult and otherwise impossible repair which gives the shop a reputation for exceptional work. Again it may be due to the successful solution of a problem of alteration or fabrication that has been brought in by a customer, which subsequently leads to similar work for the same or other customers.

A third way of increasing work and profits is to keep on the lookout, both in the shop and outside, for applications of welding and cutting that have never occurred to people less familiar with the versatility of the process. Such opportunities are almost unlimited and depend largely upon how well the operator knows the possibilities inherent in his equipment, and how alert he is to recognize how these can be utilized.—*Oxy-Acetylene Tips.*

MARINE AND NAVAL BOILERS*

***By Captain C. A. Jones, U. S. N.*† *and Lieutenant Commander T. A. Solberg, U. S. N.*††**

The purpose of this paper is to discuss, broadly, various aspects of the design and application of boilers for marine and naval purposes. Because of the complete adoption of watertube boilers by the Navy and the rapidly increasing trend toward their use for merchant vessels, only this type will be considered.

General History and Development

The watertube boiler was adopted by the Navy for practically all new construction soon after the turn of the century. This seemingly radical step at the time was, as is so often the case, a necessity, for it was only by the use and development of watertube boilers that the higher powers demanded by new types and improved designs of vessels could be met. Most of the subsequent developments have been sponsored by the very special and distinct problems imposed by naval requirements and by the economic pressure exerted by the Diesel engine. More recently, the restrictions of naval limitation treaties have stimulated progress in all branches of marine engineering, especially as regards the space and weight factors.

In the merchant marine field, the Scotch or firetube boiler has been loath to give up the position it has held. The transition to the watertube types has been generally slow except during the last five years, when it has been increasingly rapid. Economic forces and keen competition have demanded higher speed vessels of greater cargo-carrying or revenue-producing capacities. Actually, this has been achieved at very little increase in cost per ton-mile by the use of improved designs of marine power plants. Here the watertube boiler has become a necessity just as it did in the Navy; for higher pressures, higher capacities, reduced space, and reduced weight requirements could be obtained only by its use. Whereas there have existed wide differences between naval and merchant marine boiler design and practice, these are definitely disappearing today. Present-day commercial marine designs are taking more and more advantage of every benefit or improvement which has been developed in the naval and stationary services.

For a great many years the Navy assigned battleship and heavy ship duty to sectional-header, inclined, straight-tube boilers, while the small-tube express types were placed in the lighter, high-speed vessels. The inclusion of oil firing in the Navy programs, beginning about 1910, had no effect on this general procedure. The first departure from this came with the building of the high-speed light cruisers and the large aircraft carriers (begun as battle cruisers). In these ships it was necessary to go to the relatively light express designs because their weight and space factors are comparatively smaller than those of the sectional-header boilers. A further departure was evidenced by the installation of eight *A*-type small-tube express boilers in the U. S. S. *California*, the first battleship to carry such boilers. All battleships which have been modernized are fitted with small-tube express boilers.

It can be stated that as far as the Navy is concerned practically all new and modern vessels will be boilered with some design of small-tube express boiler. In the merchant marine it appears that there is a definite trend toward some type of watertube boiler, and in the case of the higher powered, combined passenger and cargo-carrying ships there seems to be an indication favoring the lighter small-tube express boiler. This is exemplified in the case of the Foster-Wheeler *A*-type boilers installed in the Grace Line steamships *Santa Elena* and *Santa*

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Table 1.—Test and Operating Data from Representative Types of Watertube Boilers

Boiler	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*
Weight, lb. (wet steaming level)	69000	114994	165366	123200	78383	153152	......	239680	259660	....
Space, cu. ft.	1580	3500	4171	4937	3125	6396	3250	......	5238	....
Boiler water heating surface, sq. ft.	4000	5221	10900	11880	6365	11720	4753	4910	10500	19050
Superheater heating surface, sq. ft.	0	521	918	0	0	2090	814	1955	2100	3400
Economizer heating surface, sq. ft.	0	0	0	0	0	0	3700	3024	Air heater	5544
Radiant surface, sq. ft.	105.8	133.17	161.8	288.4	166	285	143	160.5	9120 sq. in.	....
Caliber length *A* row	54	48	95.1	120.6	79.3	76.0	104.3	71–108	....	....
Boiler pressure, lb. per sq. in. gage	300	280	320	290	280	425	450	420	410	600
Superheat, deg. F.	0	25	203.4	0	0	215	210	357	222	260
Furnace volume, cu. ft.	445	440	1005	1137	555	1140	589	1120	1262	16150
Lb. oil per sq. ft., B.W.H.S. (on 19000 B.t.u. basis)	1.029	0.658	0.996	1.184	0.791	0.999	1.5	0.564	0.276	....
Lb. oil per hr. per cu. ft. furnace volume	9.0	8.16	11.38	10.45	9.09	10.56	12.32	2.49	3.01	....
B.t.u. release per cu. ft., furnace volume (on 19000 B.t.u. basis)	171000	155040	216220	198550	172796	200640	234000	47310	57209	26800
Equivalent evaporation B.W.H.S., S.H.S. and econ. H.S.	63347	46712 (a)	176843	185976	68311 (a)	185279	115600	47660	55833+	350000+
Equivalent evaporation per lb. oil (on 19000 B.t.u. basis)	15.39	13.06	16.262	15.714	13.56	15.81	16.23	16.92	5.8	....
Boiler horsepower	1836	1354	5125.9	5390.6	1980	5370	3350	1381	1765	....
Boiler efficiency, percent	78.64	66.71	83.04	80.26	69.38	80.73	82.81	86.42	84.4	83.8
Percent rating	459	259	470.27	453.7	311	458.2	705	139.7	168	....
Refractory surface, sq. ft.	......	292.0	453.4	445.1	263.15	405	270	......	....	....
Fraction cold	......	......	0.348	0.582	......	0.704	0.529	......	....	....
Type fuel	Oil	Oil	Oil	Oil	Oil	Oil	Oil	Oil	Oil	Oil & gas
Type burner and No. installed	Oil–13	Oil–6	Oil–12	Oil–13	......	Oil–14	Oil–10	Oil–5	Oil–10	Oil & gas–6

A. Babcock & Wilcox sectional *Oklahoma* class.
B. Babcock & Wilcox sectional-header *Maryland* class.
C. Babcock & Wilcox sectional-header express type *S X*.
D. Babcock & Wilcox 3-drum A-type express cruiser (*Pensacola*).
E. Bureau type battleship 3-drum express boiler (Thornycroft).
F. Yarrow type 3-drum express boiler for destroyers.
G. Three-drum express boiler with economizer for destroyers (design values).
H. Foster-Wheeler 3-drum express boiler for Grace Line steamship *Santa Paula*.
I. Babcock & Wilcox 3-drum express boiler for United States Lines steamship *Manhattan*.
J. Foster Wheeler 33200 sq. ft. boiler, Humble Oil Company.

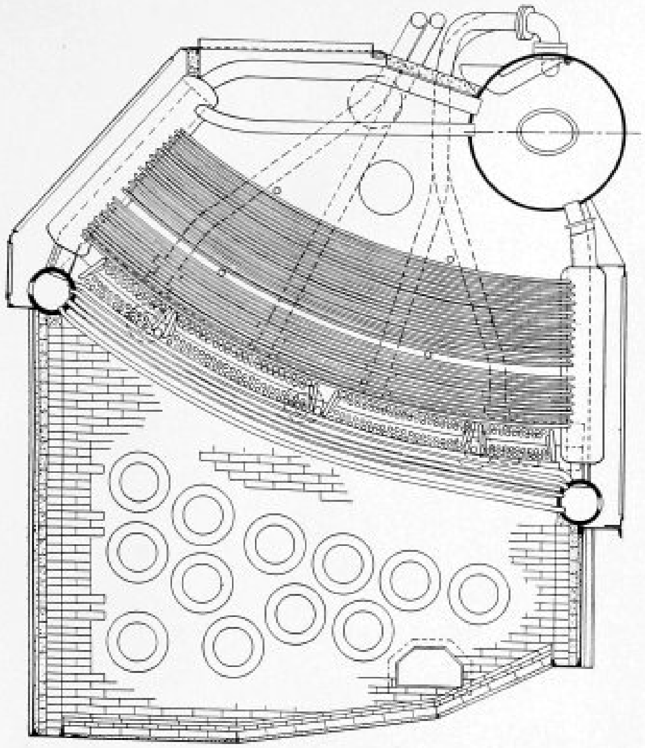


Fig. 1.—Babcock & Wilcox sectional express boiler (SX type), Unit C, Table 1

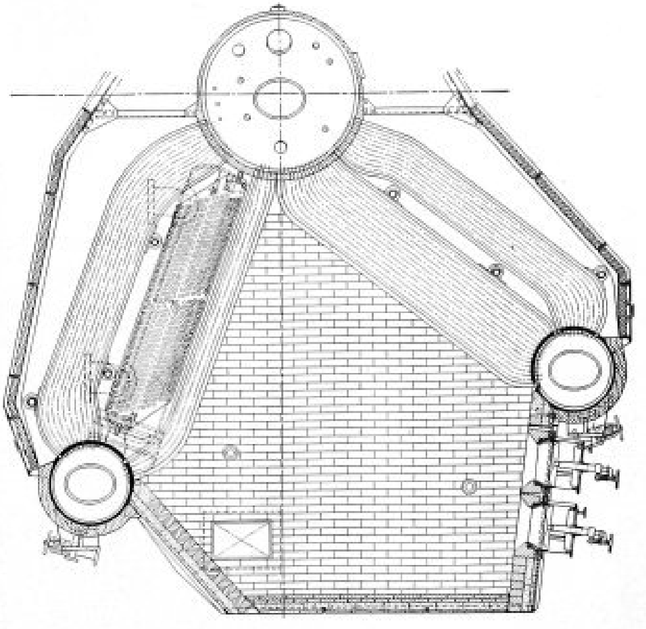


Fig. 3.—Bethlehem Shipbuilding Corporation Yarrow express boiler, Unit F, Table 1

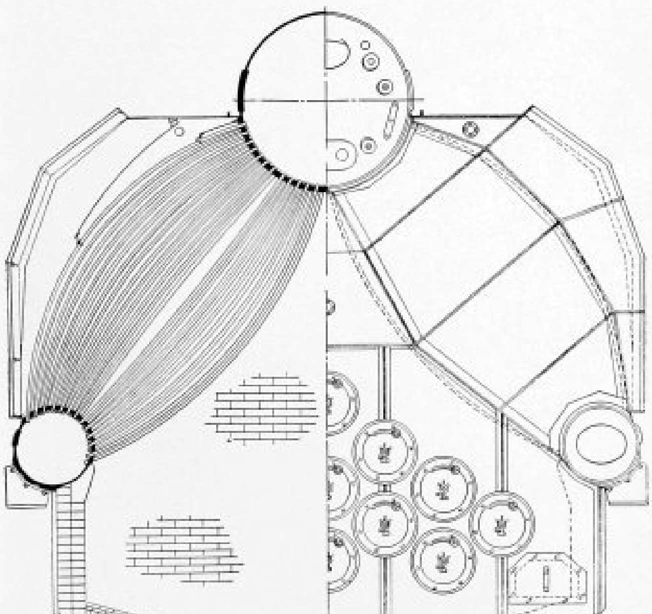


Fig. 2.—Babcock & Wilcox express boiler (A type), Unit D, Table 1

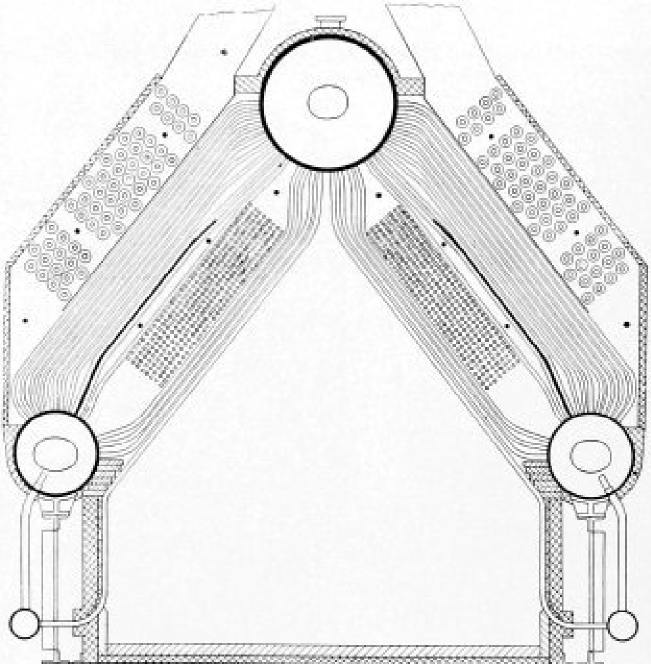


Fig. 4.—Foster-Wheeler 3-drum express boiler for Grace Line steamship Santa Paula, Unit H, Table 1

Paula and the Babcock & Wilcox boilers used in the United States Line steamships *Manhattan* and *Washington*. There have been two recent developments in sectional-header boilers; the use of small straight tubes between the conventional headers, and the use of small curved tubes between cylindrical headers in a design known as the *SX* boiler. With the adoption of higher steam pressures and temperatures, some form of small-tube express-type boiler is a necessary part of the modern installation. The principal advantages of sectional-header steam generators are their comparative simplicity of design, ease of cleaning on both fire and water sides, and facility of incorporating integral superheaters between passes or as inter-deck units. On the other hand, the objections to *A*-type boilers have been removed largely by accumulated experience and better designs in regard to the necessity and frequency of tube renewals, improvement in methods of boiler-water treatment, making frequent cleaning unnecessary, improvement in cleaning methods, and improvements in design which reduce tendencies to carry over water at high rates of evaporation. Improved condensers, further-

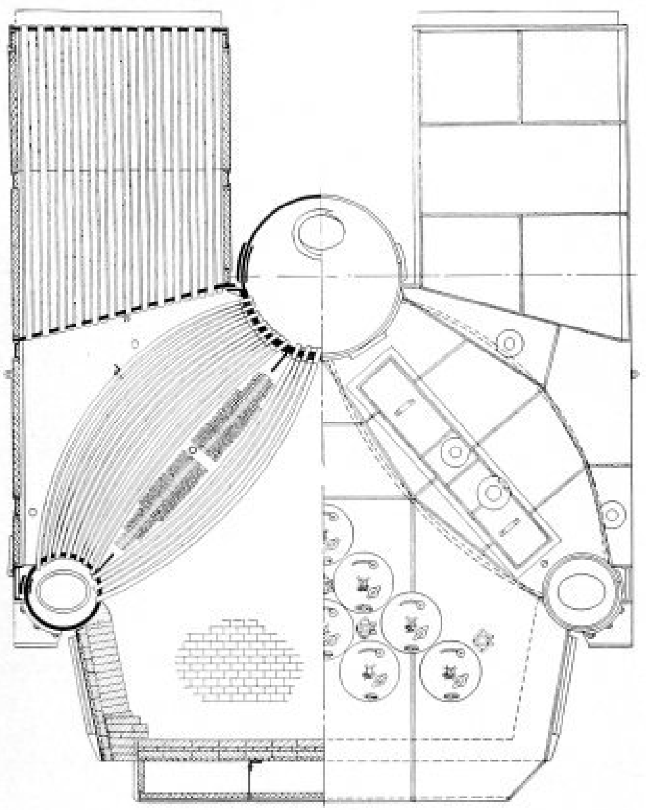


Fig. 5.—Babcock & Wilcox 3-drum express boiler for U. S. Lines steamship Manhattan, Unit I, Table 1

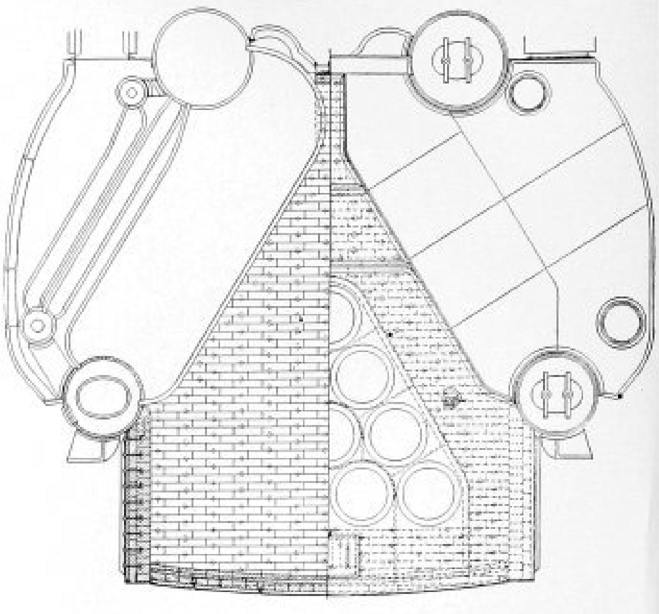


Fig. 7.—Bureau type (Cox) 4-drum boiler with economizer

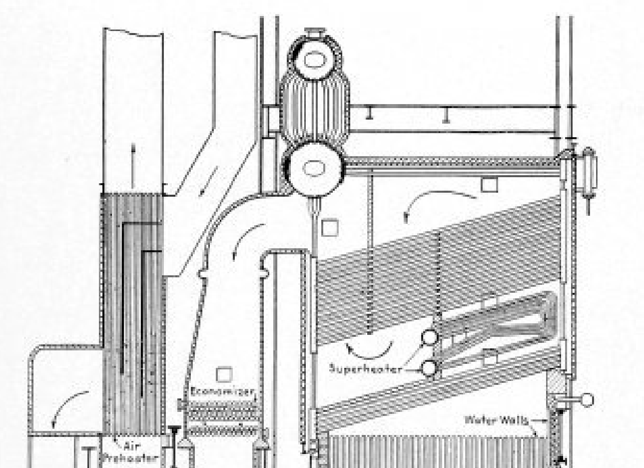


Fig. 6.—Foster-Wheeler steam generator for Humble Oil Company, Unit J, Table 1

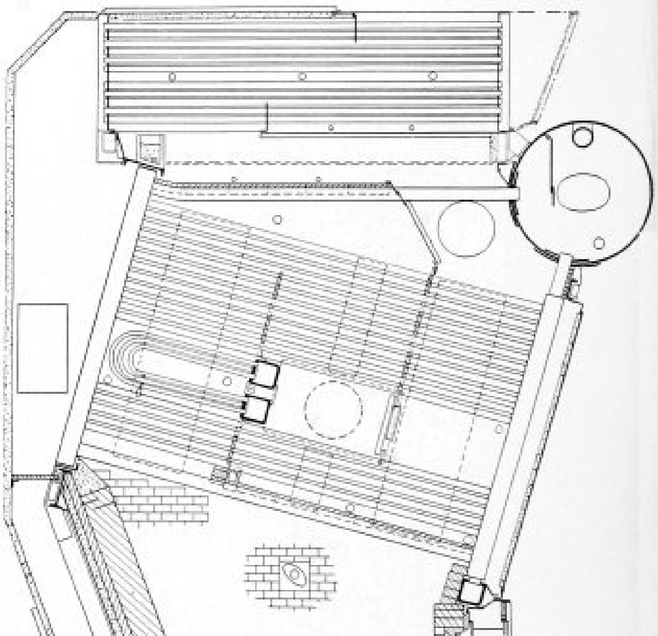


Fig. 8.—Babcock & Wilcox sectional header boiler with superheater and air heater for Matson Navigation Company steamship Mariposa: steam pressure, 391 pounds per square inch; steam temperature, 671 degrees F.

more, have reduced the probabilities of boiler-water contamination from this source. On the side of definite advantages for the three-drum (*A*-type) or similar express boilers may be listed the following.

(a) Concentration of greater boiler-water heating surface in the same space at less weight (lower space and weight factors).

(b) Greater structural strength *per se*.

(c) Baffling within tube nests is unnecessary.

(d) Excessive number of openings (hand-holes) obviated; therefore less cost of material for overhead.

(e) More rapid steaming and more rapid response to load fluctuations.

(f) Some designs permit greater flexibility in burner

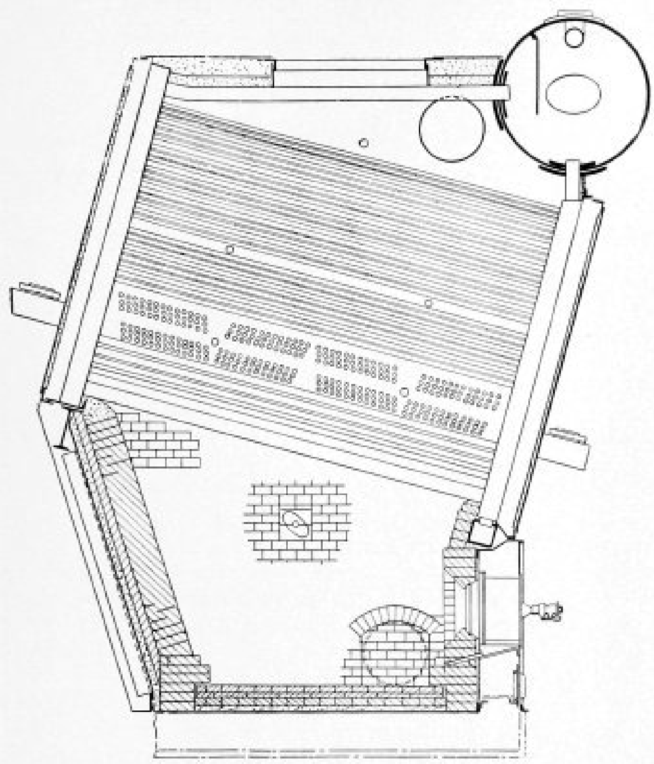


Fig. 9.—Babcock & Wilcox sectional header marine boiler with superheater for Seatrain Lines, Inc., steamship Seatrain New York: steam pressure, 414 pounds per square inch; steam temperature, 700 degrees F.

arrangement and provide better flame support for complete combustion.

(g) Ability to stand forcing with resultant high rates of evaporation.

General Comparison of Boilers

It is of interest to glance at the more important characteristics and salient features of several modern boilers shown in Figs. 1 to 9, inclusive. Units representative of large numbers now in use have been selected, and their available test and operating data are presented in Table 1. A study of this tabulation will indicate many interesting differences between the various types and applications.

From the standpoints of weight and space, which are so all important to the naval designer, it is apparent that the three-drum express boiler is the most attractive at pressures up to and including about 450 pounds gage. Comparison of the S.S. *Manhattan* boiler with a new destroyer boiler indicates that they have approximately the same heating surface and operate at nearly the same pressure and temperature. The commercial boiler, including its air heater, outweighs the naval unit by 106,500 pounds and has an evaporation rate per square foot of heating surface (exclusive of air heater) only about one-third of that of the naval boiler. There is, however, a gain of efficiency. In the case of the S.S. *Santa Paula* boiler, which has less than one-half the heating surface of the same destroyer steam generator, the weight, nevertheless, is *about 57 percent* greater. The evaporation rate, however, compares much more favorably than in the former case.

The entries for furnace volumes and heat releases per cubic foot of furnace volume per hour show some striking differences. Whereas, in land and merchant marine practice the maximum heat releases rarely exceed 50,000 and more nearly average 18,000 B.t.u. per cubic foot per hour, it is seen that in naval boilers figures of 200,000 are not unusual.

The efficiencies of recent naval boilers, despite their handicaps of space and weight and no waste-heat recovery apparatus, exceed 80 percent at ratings in the order of 500 percent; and, because of their high evaporation rates per square foot of heating surface, the relatively small naval boilers have steam capacities in the neighborhood of 200,000 pounds per hour. Land units having these outputs are not unusual but are considered to be of great size.

Discussion of Factors Involved in Design of Naval Boilers

The following discussion, although primarily centered on naval boiler design, is in most respects applicable also to merchant vessel steam generators. Likewise, many of the points covered can be related to land practice, but the limitations placed on naval designers may preclude the adoption of many features found desirable on land. These special limitations and requirements, however, have developed refinements and design features which are being incorporated in both merchant vessel and stationary boilers. No attempt, however, will be made to indicate differences or characteristics of naval boilers which might be incorporated in the other types. Ten years ago wide differences in design existed between naval and commercial boiler practices, but these definitely are becoming less apparent. It is pertinent, however, to state that while in the commercial field the type of boiler is dictated almost entirely by economic considerations, in the Navy this is secondary as the selection is made on the basis of obtaining the maximum power with the least weight and within the minimum space without sacrifice of the other general requirements which will be discussed later.

General Requirements of Naval Boilers

The general requirements of naval boilers are largely obvious and therefore can be stated briefly with little or no discussion.

(*a*) *Maximum Reliability.* They must be capable of delivering full power efficiently and consistently for long periods. Necessity for major repairs at any time must be kept remote and facilities and arrangements must be such that all ordinary repairs can be readily made by the forces afloat.

(*b*) *Weight and Space.* These factors must be such that the units can be fitted easily into their allotted space in the ships without exceeding the weights allowed for this part of the power plant. In this connection it should be remembered that space limitations usually are tri-dimensional. These items affect the possibility of utilizing waste-heat recovery apparatus.

(*c*) *Economy.* The maximum attainable efficiencies must be realized. The efficiency curve must be as nearly flat as possible over the entire operating range. This factor also is related to sub-paragraph (*b*) above. Cruising radii and time of maintenance of maximum speed are involved.

(*d*) *Maneuverability and Ease of Operation.* Naval vessels are called upon to operate under all possible conditions, and changes in operating requirements are liable to be frequent and without warning.

(*e*) *Vulnerability.* The complete machinery installation must be afforded the maximum possible protection from shell fire, aircraft bombs, gas and torpedoes.

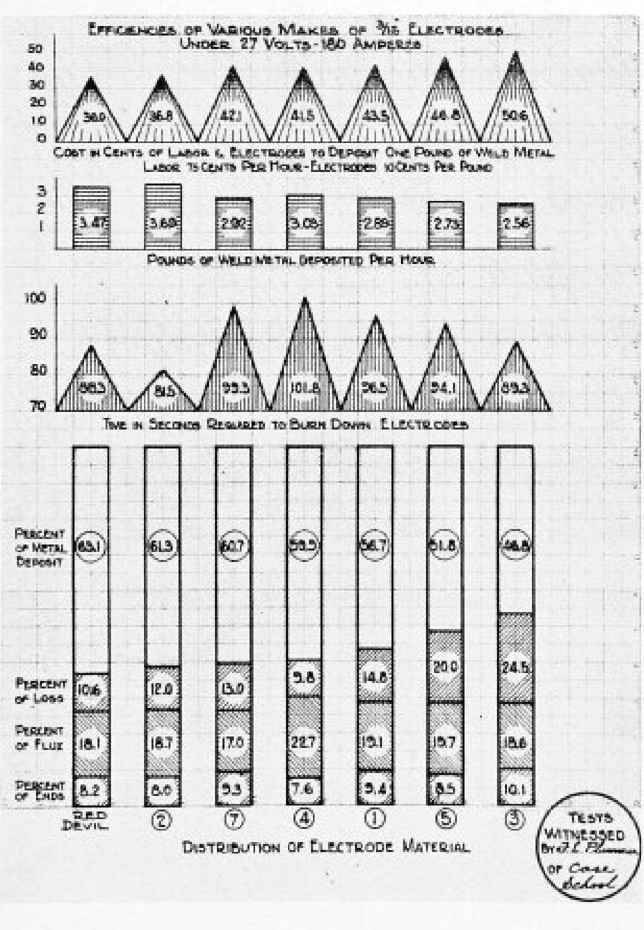
(*To be continued*)

Scientific
Method of Selecting

WELDING ROD COATINGS

It is common knowledge that various makes of shielded arc welding rods have individual characteristics in welding operations. A very slight change in the chemical composition of the material of the covering is likely to change the welding results obtained by use of the rod to a considerable degree. In the present state of development of the art of welding and the materials used in welding operations, the manufacturer of the welding rod is confronted with the necessity of making a decision on the question of whether he proposes to make a universal welding rod which is adaptable to all conditions or whether he proposes to manufacture welding rods which permit optimum results under specified conditions. The research department of the Champion Rivet Company, Cleveland has adopted a unique course in that it has placed before the user two distinct types of rods—Red Devil for specific conditions and Blue Devil for universal applications. The reasons for so doing may be of interest to the user of welding rods due to the fact that his costs and difficulties in getting satisfactory welding results are inextricably mingled with the characteristics of the welding rod he uses.

The main purpose of the covering on the welding rod is, of course, to shield the molten metal from atmos-



Comparative performance of Red Devil electrodes with other makes

pheric contamination during the welding operation. A secondary purpose is to flux the molten metal, for re-finement purposes, after it has passed across the weld-ing arc and is deposited on the piece being welded. Th operation is analogous to the operation of an electri arc furnace. But the welding arc is only analogous an not similar to the operation of an electric arc furnace In the furnace, a whole heat of steel is made. In weld-ing, steel from a welding rod is merely fused to a stee which may or may not be uniform in structure an analysis. It is well known, for instance, that even i high grade flange and firebox steels there are variation in chemical analysis from heat to heat and even from plate to plate of the same heat. Not only is this varia-tion a factor which enters into the success of th welding operation, but the variation in chemical analysi and structure between the surfaces and center of plate of considerable thickness. These are variables ove which the welding rod manufacturer has no control. H may select with great precision the steel which goes int the welding rod he manufactures but he cannot select th steel which is to be welded with his product. The speci-fications covering steel for welding are continually bein drawn more closely by such authorities as the America Society of Mechanical Engineers Boiler Code, Amer-ican Society for Testing Materials, Society of Automo-tive Engineers and large users of steel for welding but it is quite generally recognized that existing speci-fications of a public nature are essentially specification covering steel for use with riveted connections. A obvious prerequisite, therefore, of the shielding and flux-ing elements on the welding rod is that they shall mak possible the welding of commercial steels the user ca buy on the market and that the shielding and fluxin elements shall compensate for the variations.

The variations just described may be considerable bu it is a fact that they are manageable and the proble of compensating for them in the shielding and fluxin materials placed on the welding rod may be placed o the sound foundation of measurable variations. How-ever, such is not the case with variations in weldin technique.

In either manual or automatic arc welding, unfavor-able conditions for welding may be present, althoug in automatic welding the conditions are much mor easily controlled. Too long an arc, too short an ar too much heat, not enough heat, improper rate of trave too thick a welding bead, improperly designed weld ker and other unfavorable conditions may result in unsatis-factory welding. In the manufacture of shielded ar welding rods, it is possible in some degree to de-sensitiz the welding rod to unfavorable welding conditions suc as those mentioned above. Thus, a mineral coated weld-ing rod for downward welding may be made less sensi-tive to improper welding conditions, but the same ro may be extremely sensitive to improper welding con-ditions in the sidewise and overhead welding.

From the point of view of precedent, it seems ver probable that more positioned welding has been don with mineral coated welding rods than with weldin rods containing volatile matter, which would tend t

Recommended procedure in the use of Red Devil electrodes

(Reverse polarity is desirable, D. C. or A. C.)

Diameter—inch	Amperes	Voltage
1/8	100—140	30—35
5/32	120—170	30—35
3/16	190—240	35—40
1/4	250—375	38—45
5/16	290—425	40—47
3/8	400—650	45—50

verify the position of the research department in offering the mineral coated rod for welding in the downward position on flange or firebox steel or equivalent steels of different designation. English and Continental welding practice has required the use of mineral coated welding rods for more than fifteen years. A considerable number of the most outstanding welding operations in this country in the last two years has been carried out with mineral coated welding rods. The margin of safety against unfavorable conditions for welding, as shown by a large accumulation of experience, is greater with mineral coated welding rod than it is with other types of welding rods designed to shield the weld metal from atmospheric contamination.

The necessity for a large margin of safety with reference to the effect of unfavorable welding conditions is a matter of common knowledge among users of welding. The previously mentioned variation in the chemistry of the steel itself is an acknowledged condition with which German, English and American steel makers have contended for many years. Continuous research has been carried out for the past twenty-five years on the problems involved in making steel uniform. While the matter was one of great significance, when riveted and other mechanical connections were being used, which did not involve heating of the metal to the melting point, widespread use of fusion welding has made the problem still more acute. Welds which must pass X-ray inspection must be free from any considerable degree of porosity regardless of the normal variations in the steel of the plate. A welding rod which is sensitive to such variations results in more welding which has to be cut out and re-welded.

It is the human factor, however, which results in variation of the technique which causes the rejection of most improperly made welds. Extremely high grade welding is a process which requires close adherence to standard procedure if the results are to be uniformly good. Change in personnel, dissatisfied workers, uncomfortable working conditions, expedited deliveries and other common disturbances which might not affect other manufacturing processes often produce effects in quality of welding which are undesirable and necessitate re-welding. With welding rod which is sensitive to off standard technique, these troubles are accentuated. On the other hand, mineral coated welding rod designed specifically to give the lowest possible degree of sensitivity to off standard technique constitutes a safety factor of considerable importance in practical management of a welding department.

It is with these factors in mind that this company developed the Red Devil mineral coated electrode for welds requiring X-ray examination. These welding rods are extremely effective in de-sensitizing unfavorable conditions in the arc welding operation. The coating not only forms a reducing atmosphere around the arc and produces sufficient slag to permit the metal to cool slowly, but the fluidity of the slag is controlled so as not to permit of its running ahead of the arc and does not form slag pockets along the edges of the weld. The high refractory nature of its coating permits of its use

Report of Metallurgical Department

PHYSICAL PROPERTIES

Purchaser The Champion Rivet Co.

Address

Order No. Regular Shop Test.

Manufacturer. Address.

Mfgrs. Designating No. W (Dept.) (Serial) Test No. 362- (Date) R. D. (Serial) Date of Test 10/16/34

Welding Operator—Name F. M. W. Number

Tested By Reason for Test

Plate Thickness 1¼" Plate Specification A. S. M. E.

Type of Weld flat Kind of Welding Wire Red Devil Type of Welding Groove U

If Stress relieved, describe as welded condition

REDUCED SECTION TENSILE TEST

Specimen No.	Dimensions Width	Dimensions Thickness	Area	Total Load, Lbs. Yield Pt.	Total Load, Lbs. Ultimate	Unit Stress, Lbs. Sq. Inch Yield Pt.	Unit Stress, Lbs. Sq. Inch Ultimate	Character of Failure and Location
	1.48	.80	1.184	52.810	76160	44700	64500	

.505" ALL-WELD TENSILE TEST

Specimen No.	G Dimensions Width	G Dimensions Thickness	Area	Total Load, Lbs. Yield Pt.	Total Load, Lbs. Ultimate	Unit Stress, Lbs. Sq. Inch Yield Pt.	Unit Stress, Lbs. Sq. Inch Ultimate	Character of Failure and Location
	.505		.2003	10.440	13260	52100	66200	

Elongation $= \frac{E_1 - E \times 100}{E} = \frac{262-2}{2} = 31\%$

Reduction of Area $= \frac{A - A_1 \times 100}{A} = \frac{.505-345}{.505} = \frac{2003-935}{2003} = 53.2\%$

FREE BEND TEST

Specimen No.	Gage Length Before Bending	Gage Length After Bending	Difference	% Difference	Remarks

SPECIFIC GRAVITY TEST

Specimen No. $\frac{W}{W - W_1} = \frac{35.98}{35.98-31.40} = 7.856$ Remarks

F. J. Z.
Research Engineer

Physical properties of Red Devil electrodes

at considerably higher heats than is customary with other types of rods. This feature is productive of greater speed in the welding operation.

The electrode should be pointed as to form an angle with the work of approximately 60 degrees. A slight criss-cross weaving motion may be used, hesitating slightly at the end of each stroke. Use the proper size rod for the purpose intended. This will increase the speed and reduce costs.

Details of Blue Devil electrodes for vertical and overhead welding will be published in a subsequent article.

Railroad Machine Tool Purchases in 1935

In spite of the fact that most railroads are still operating under policies involving curtailed expenditures, 55 roads, representing 63.5 per cent of the route mileage of the United States and Canada, reported purchases of machine tools and shop equipment for locomotive and car shops during 1934. Some of the more important items ordered were as follows:

Type of Machine	Number of units
Drilling machines	13
Hydraulic presses	2
Milling machines	4
Grinders	24
Shapers	1
Planers	3
Engine and turrent lathes	28
Boring machines	10
Welding machines:	
200 amp.	3
300 amp.	29
400 amp.	11
400-450 amp.	10
750 amp.	1
Unclassified	5
Plate-forming machines	7
Woodworking machines	8
Metal sqws	5

A Rivet Tip

One of the most important details in driving rivets is the shape of the "hold on" set or dolly.

In order to get satisfactory results and a well finished head it is absolutely necessary to change the shape of the manufactured head. In other words, the "hold on" set should not have the same dimensions as the rivet head. Acorn or hi-button heads should be reshaped or driven into a standard button head; a button head should be driven into a low button; a cone head should be driven into a standard button head, etc. This method of driving will prevent an accumulation of loose scale in the dolly which causes pitting of the head. Pitting gives a poor appearance and is often rejected by the inspector who insists on cutting out the rivet and replacing it.

Engineering Index Reorganized as Co-operative Enterprise

Engineering Index, Inc. will appeal to the nation's industry operating in technical fields for a working capital fund of approximately $160,000 with which to continue the service and spread its use throughout the engineering offices, libraries and colleges of the country, over a five-year period after which it is estimated it will be self-sustaining. This project has just been announced by Collins P. Bliss, Dean of the school of engineering at New York University and president of the Board of Directors of the Index.

Thus will this fifty-year-old engineering institution enter a new and wider field, according to Dean Bliss. At the annual meeting of the American Society of Mechanical Engineers in 1933 it was voted to discontinue the society's responsibility for, and financial losses accruing from, the operation of the Index. This decision became effective the beginning of 1934. In June of 1934 the Index was formally incorporated as a non-profit organization in its own right. This followed an extensive study by an outside organization which developed the following conclusions:

The Engineering Index service is unique in its field and, for scientific purposes, is not duplicated by any other indexing and abstracting service.

If it were not for the Index, the engineering field would be the only major field of scientific knowledge without a complete and effective organization of its current literature.

To those not already familiar with the Index, it may be described as a virtually complete catalogue, with annotations, of technical literature in all branches of engineering. The merits claimed for the service include completeness, descriptiveness, promptness and accuracy.

The Index is published in two separate forms. The annual volume is roughly similar to complete indexes in other scientific fields, such as Index Medicus in the medical field. More unique is the Card Service which is a cumulative card index of technical literature sub-divided into approximately 280 divisions which may be had in any desired combination. About 2000 publications are reviewed by Index editors. These periodicals come from 40 different countries and are in 20 languages.

The present board of directors includes, besides Dean Bliss, Harold V. Coes, manager of the Industrial department of Ford, Bacon and Davis; Ralph E. Flanders, president of Jones and Lamson Machine Company; Robert M. Gates, vice-president of Combustion Engineering Company, Inc.; and Clarence F. Hirshfeld, chief of the Research department of Detroit Edison Company.

The charter of the Index, which describes the typical membership, non-profit corporation under the New York State law, provides for 50 trustee members who, Dean Bliss says, are to represent all the important engineering bodies in the country. Enlistment of this group has only begun, but now includes Mr. Flanders, president of the American Society of Mechanical Engineers, to represent that society; Miss Granville Meixell, Librarian of Applied Science Library at Columbia University, to represent the Special Libraries' Association; C. L. Warwick, secretary-treasurer of the American Society for Testing Materials; F. C. Zeisberg, development department of the E. I. DuPont de Nemours Company, representing the American Institute of Chemical Engineering; and Lester C. Morrow, editor of "Factory Management and Maintenance," representative at large.

The plans for the campaign call for a National Campaign Committee, and local committees for each of twelve industrial centers. National Committee headquarters have been established in suite 1716-18 of the National Association Building, 25 West 43rd St., New York.

Welding Concern Provides New Consulting Service

The C. H. Dockson Company, Detroit, has announced that William Zorn, formerly welding engineer for the Detroit Edison Company, has joined its organization in the capacity of consultant welding engineer.

Mr. Zorn's services, as a consulting engineer or as a speaker, will be available to anyone with arc welding problems in the middle west.

His experience embraces every phase of metallic arc welding, including atomic-hydrogen welding, tank and structural welding, high and low-pressure piping, alloys, hard facing, etc., as well as gas welding and cutting.

During his association with the Detroit Edison Company he has been in complete charge of all welding operations, one of his recent achievements is the completion of welding the main steam lines of new units which operate at 650 pounds per square inch pressure and 850 degrees F. superheat.

His previous connections with the Steere Engineering Company of Owosso, Mich.; Hydraulic Pressed Steel Company, Cleveland; Van Dorn Iron Works, Cleveland; New York Central Railroad Company, Cleveland, and the Baltimore and Ohio Railroad Company give him a practical experience in all phases of the welding process.

Mr. Zorn also does his own experimental welding in testing new rods and equipment. He has written many papers on welding and given many talks before technical societies. He was recently winner of the sixth prize of the Lincoln Second Annual Prize Contest.

Although Mr. Zorn was born in North Baltimore, O., in 1894, when the World War started he joined the Canadian Army in 1915, being a member of the 10th Infantry Battalion, First Division, Second Brigade. In 1918 he was transferred to the United States Army and during that year lectured on the war during Liberty Loan Campaigns. Following this he spent considerable time lecturing on the same subject for Redpath Chautauqua circuits.

Mr. Zorn is also a very active member of the American Welding Society.

Boiler Maker and Plate Fabricator

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Request for change of address should reach us on or before the 15th of the month preceding the issue with which it is to go into effect. It is difficult and often impossible, to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address, please be sure to send us your old address as well as the new one.

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EDITORIAL STAFF: H. H. Brown, Editor. L. S. Blodgett, Managing Editor.

Contents

Trade Publications

Safety Heads for Pressure Vessels.—A bulletin, issued by Black, Sivalls & Bryson, Inc., Oklahoma City, Okla., describes a safety head developed for prevention of excess pressure. This safety head bears exactly the same relationship to pressure systems as the electric fuse bears to the electric circuit. They have enormous relieving capacity—many times that of average safety valves. Nothing can happen to cause them to stand excess pressure since they cannot be screwed down like safety valves, nor can they corrode shut. When the pressure gets to the right height they are sure to burst clear and save the vessel in which they are installed.

Plate Material.—The service maintained by the By-Products Steel Corporation, Coatesville, Pa., in the supply of sheared plates, pressed shapes and steel blanks made to order is outlined in a folder issued by the company. In this folder a wide variety of the specialty products of the company are illustrated.

Champion Welding Electrodes.—The name Champion has been closely associated with the plate fabricating industry in all its branches for the past forty years. During this period the rivets produced by this company became established as a basis for producing quality joints. For the past four years the name Champion on welding electrodes has taken on the same significance as that enjoyed formerly for rivets alone. Results claimed for Champion electrodes warrant a careful investigation by the users of welding products. The present catalogue issued by the Champion Rivet Company, Cleveland, is devoted to the details of the complete line of electrodes now produced by the company, their characteristics and quality features for various types of welding.

Steel Plate Products.—The Downingtown Iron Works, Downingtown, Pa., is distributing a bulletin illustrating the wide variety of steel plate products fabricated by the company. Plate fabrication of every type and for all purposes is carried out in a wide variety of materials, including ordinary carbon steel, chrome iron and chrome-nickel alloys, nickel clad steel, "Everdur," aluminum, monel metal, pure nickel, and stainless-clad steels. The following items of production indicate the wide range covered: Acid tanks, air pressure tanks, blow-off tanks, brine tanks, elevator tanks, filter tanks, fuel oil tanks, galvanizing tanks, grease tanks, jacketed tanks, pressure tanks, rendering tanks, blast piping, breechings, coal bins, calandrias, gas pipe, hoppers, hydraulic mains, lime kilns, oil stills, pontoons, riveted pipe, steel stacks, buoys for breweries, copper lined washers, CO_2 gas storage tanks (with pipe and fittings), beer storage tanks, fermentation tanks, hop jacks, storage bins, hot water tanks, etc. The company is prepared to handle any problems in the design and fabrication of riveted and welded steel plate construction. In the many special problems encountered in this class of work, experienced engineers are available for consultation and design. Fabrication also covers special designs to purchaser's specifications, and certain classes of erection work in the field is handled. The Hartford Steam Boiler Inspection and Insurance Company has "approved" Downingtown's procedure to build arc-welded A.S.M.E. unfired pressure vessels, of classes 2 and 3—in shell thickness up to and including 1¼ inches.

Business Notes

Hunter Michaels has been appointed district sales manager of the American Locomotive Company, with headquarters at Cleveland, Ohio, succeeding William E. Corrigan.

W. R. Walsh, resident sales manager at Chicago for the Ewald Iron Company, Louisville, Ky., has been elected a vice-president of the company, with headquarters at Chicago.

O. B. Capps, formerly eastern sales manager for the old Locomotive Stoker Company of Pittsburgh, Pa., is now representing the Standard Stoker Company, Inc., having his headquarters at its New York office at 350 Madison avenue, but maintaining his residence at Oceana, Va.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on practical boiler shop problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given special permission to do so.

By George M. Davis

Scotch Boiler Reinforcing Patch

Q.—Having been a subscriber to *Boiler Maker and Plate Fabricator* for several years, I would like to request the Questions and Answers Department for comment regarding repairs to a Scotch boiler as per enclosed sketch. This boiler has been reduced in thickness by corrosion where it rests on the saddle and is to be repaired by reinforcing the bottom of the shell by attaching a patch on the inside of the shell. The first plan submitted was to cut out the thin spot and patch from the outside, as it would be impossible to enter the patch through the manhole opening. The shell plate has been reduced from 0.825 inch to 0.529 inch. W. G.

A.—The thickness of the shell plate being reduced from 0.825 inches to 0.529 inches gives an efficiency through the reduced section of $\frac{0.529}{0.829} = 62.9$ percent, which is no doubt considerably under the efficiency of the longitudinal seam of the shell course affected, thus requiring that the shell course be reinforced or renewed.

The patch to be attached on the inside of the shell as proposed in the question is illustrated.

There is not sufficient information given in the question to make a detail check of the patch but the general information supplied would indicate that the patch would not be satisfactory.

The thickness of the patch should be at least equal to the thickness of the shell to which it is attached.

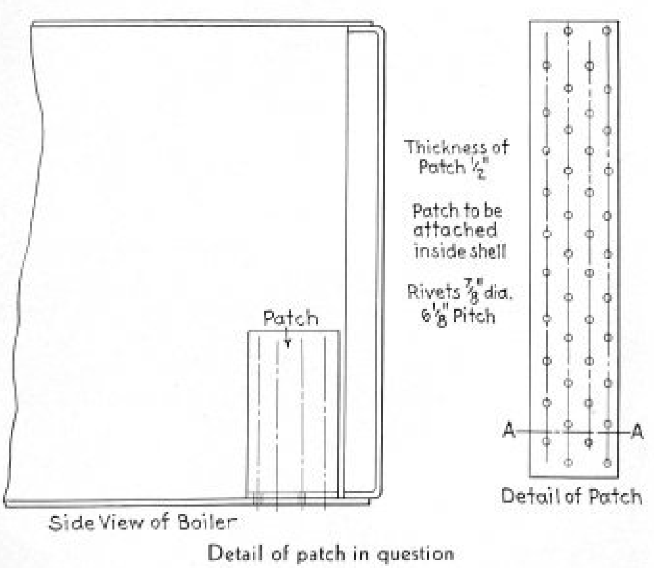
The information given in the question does not indicate to what extent the reduction in cross-section due to the corrosion has taken place; for instance, if the corroded condition stated in the question existed through section A-A, the reduction in strength for a 14-inch width would be:

14 $(0.825 - 0.529) \times 55{,}000 = 227{,}920$ pounds, while the strength added by the patch would be 4 — ⅞-inch rivets in single shear or

$4 \times 0.6903 \times 44{,}000 = 121{,}492$ pounds, indicating that the strength of the patch does not compensate for the metal lost due to corrosion.

The patch should be so designed that, through any section of the patch, the efficiency of the construction, that is, the shell and the patch, through the section considered, has an efficiency at least equal to the efficiency of the longitudinal seam of the shell course to which the patch is applied.

I believe that the best solution would be to remove the section of the shell course affected by the corrosion and apply a new part shell course.



Detail of patch in question

Water Discharged in Blow Down

Q.—(1) Given a locomotive boiler under 200 pounds steam pressure, what quantity of hot water in pounds and gallons would be discharged to the atmosphere per second through a 2-inch diameter straight blow-down valve?

(2) Can you give a simple formula for figuring similar problems under varying steam pressures? I find textbook formulas on steam flow and cold water flow do not give correct figures, and can find no tables on hot water flow under pressures. W. M. C.

1.—The formula for computing the flow of water under pressure through an orifice is

$$V = 0.98 \sqrt{2g\ (h + h_1)}$$

where;
V = velocity of flow in feet per second
g = force of gravity in feet per second, per second = 32.16
h = head in feet
h_1 = head due to pressure $= \frac{P}{0.434}$
P = pressure in pounds per square inch. 0.434 = pounds per square inch due to one foot of head
0.98 = coefficient of velocity—this quantity is empirical. Experiments indicate that the coefficient of velocity is approximately 0.98 and varies very little with the head.

The formula for quantity of flow is:

$$Q = 0.62\ AV$$

where;
Q = discharge in cubic feet per second
A = area of orifice in square feet
V = velocity of flow in feet per second
0.62 = coefficient of contraction

The coefficient of contraction is empirical. It is the relation of the area of the orifice to the area of the jet at a distance out from the opening about one-half its diameter and is taken about 0.62 of the orifice area.

The formula does not take into consideration the change in the head above the blow-off cock due to the discharge. The effect of the change of head would be very small considering that the head due to pressure is so much greater than the head due to the height of the water in the boiler.

Assuming that the head due to the height of the water in the boiler above the blow-off cock is 6 feet and substituting the values given in the question, we have

$$V = 0.98 \sqrt{2 \times 32.16 \left\{ 6 + \frac{200}{0.434} \right\}}$$

$$V = 0.98 \sqrt{64.32\ (6 + 460)}$$

$$V = 0.98 \sqrt{64.32 \times 466}$$

$$V = 0.98 \sqrt{29973.12}$$

$$V = 0.98 \times 173.1$$

$V = 169.64$ feet per second

$$Q = 0.62 \times \frac{3.142}{144} \times 169.64$$

$Q = 2.294$ cubic feet per second.

1 cubic foot of water = 7.481 gallons.

$2.294 \times 7.481 = 17.16$ gallons per second.

The weight of water varies with the temperature. The temperature varies with the pressure. From "Marks and Davis" tables we find that at a pressure of 200 pounds per square inch, the temperature of the water is 381.9 degrees F. Assuming that the temperature is uniform throughout the boiler and taking the weight of the water from Table I, interpolating we have.

One cubic foot of water at a temperature of 381.9 degrees weighs 54.276 pounds per cubic foot.

TABLE I.—WEIGHT OF WATER AT VARIOUS TEMPERATURES

Temperature Degrees F.	Weight Per Cubic Foot Pounds	Temperature Degrees F.	Weight Per Cubic Foot Pounds
32	62.42	290	57.65
39.2	62.43	300	57.33
40	62.43	310	57.00
50	62.42	320	56.66
60	62.37	330	56.30
70	62.30	340	55.94
80	62.22	350	55.57
90	62.11	360	55.18
100	62.00	370	54.78
110	61.86	380	54.36
120	61.71	390	53.94
130	61.55	400	53.5
140	61.38	410	53.00
150	61.20	420	52.6
160	61.00	430	52.2
170	60.80	440	51.7
180	60.58	450	51.2
190	60.36	460	50.7
200	60.12	470	50.2
210	59.88	480	49.7
212	59.83	490	49.2
220	59.63	500	48.7
230	59.37	510	48.1
240	59.11	520	47.6
250	58.83	530	47.0
260	58.55	540	46.3
270	58.26	550	45.6
280	57.96	560	44.9

The weight of water discharged per second would be
$2.294 \times 54.276 = 124.5$ pounds per second.

Maximum Diameter of Staybolts

Q.—I will be pleased if you will give me your views on the maximum diameter of staybolts that should be used, in staying the fireboxes or water legs of vertical and vertical extended firebox, and locomotive boilers, as there appears to be quite a difference of opinion. L. D.

A.—The maximum size of staybolts to be used in staying the fireboxes or water legs of vertical and vertical extended firebox boilers is limited by the A.S. M.E. Code for Power Boilers in that the maximum spacing of staybolts permissible for a given thickness of firebox sheet is specifically stated and also the maximum allowable stress for staybolts is limited to 7500 pounds per square inch for unwelded staybolts less than twenty diameters long, screwed through plates with riveted ends.

Thus the spacing of the staybolts is definitely limited for any given condition of plate thickness and boiler pressure and the required size of staybolt to support this area is readily computed. Nothing is to be gained by making the staybolts larger than the required diameter as the allowable stress provides an ample factor of safety of from 6 to 7.

For locomotive boilers the Interstate Commerce Commission has also set a limit of 7500 pounds maximum stress per square inch of net cross-sectional area of firebox and combustion chamber stays.

The proceedings of the Master Boiler Makers Association recommends for locomotive boilers that ⅞-inch diameter staybolts be applied as a minimum and that 1-inch diameter be the maximum size and that bodies of rigid staybolts beyond 1 inch be turned down to $^{25}/_{32}$ inch between the sheets.

Using maximum diameter staybolts to support a given area, with the idea of keeping down the number of staybolts used is not desirable; smaller diameter staybolts are more flexible and give greater life to fireboxes than large diameter bolts.

An analysis of staybolt action would indicate that they do not break from direct or tensile load, the liberal factors of safety used would indicate that, and therefore other stress must be the cause of staybolt breakages.

One cause of staybolt breakage is the movement of the firebox sheets in relation to the outside or wrapper sheets. There is no doubt that the movement is considerable, due to the different conditions affecting the sheets. The outer sheet is exposed to the atmosphere and to the water temperature, the inner sheet to the water and fire temperatures, and these are modified in turn by mud and scale to the serious disadvantage of the firebox sheet, hindering its conductivity of the heat to the water and causing a higher degree of expansion and subsequent contraction.

These movements of the sheets give the staybolts an angular or lateral pull and are most severe when there are the greatest temperature differences in the firebox.

These extreme differences occur in hasty firing up, cooling down, cold water washing or filling, and from cold drafts after the fire is knocked out. When the boiler is in normal operation, it is doubtful if the angular stresses are excessive and it is probable that the initial rupture, the first start of the breakage, occurs at some firing up time or other period of extreme temperature variation.

Staybolts break under the pull due to pressure, but only after the cross-section has been reduced by checking, a partial fracture induced by over stressing of the outer fiber of the staybolt at times of extreme movements.

The larger the bolt beyond actual requirements the more probability of its early failure, for the obvious reason that the stiffness and rigidity increases with the size, and large bolts are unable to respond to the firebox movements very many times before the fracture starts which ends with a broken bolt.

Almost invariably solid bolts break close to the outer sheets and due to this, the practice of drilling a telltale hole in the outer end gives warning of a broken or fractured bolt. The reason for the location of breakage is because the outer sheet is always heavier than the inner, is not as subject to movement and acts as a foundation for the staybolt, the other end of which is pulled laterally by the firebox movement.

Flexibility consistent with strength is a desirable and necessary feature in determining staybolt diameters; increase of size and strength decrease the element of flexibility upon which the life of the staybolt depends.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.

Assistant Chief Inspectors—J. M. Hall, Washington, D. C.; J. A. Shirley, Washington, D. C.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Assistant Director—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.

Vice-Chairman—D. S. Jacobus, New York.

Acting Secretary—M. Jurist, 29 W. 39th Street, New York.

Honorary Secretary—C. W. Obert, New York.

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Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.

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California	New Jersey	Utah
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Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
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Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
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Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
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	Philadelphia, Pa.	

Selected Patents

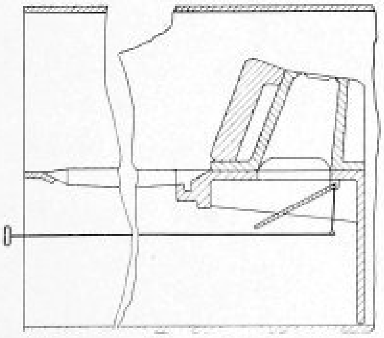
Compiled by Dwight B. Galt, Patent Attorney, 1372-1376 National Press Building, Washington, D. C. Readers wishing copies of patents or any further information regarding any patent described, should correspond directly with Mr. Galt.

1,856,732. STEAM BOILER. CHARLES A. SELEY, OF CHICAGO, ILLINOIS, ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

Claim.—A steam boiler embodying therein a shell, a plurality of laterally spaced combustion chambers therein, a furnace opening into each combustion chamber, and means arranged between said combustion chambers and cooperating with the sides thereof to provide an unrestricted duct open at its top and bottom, said duct being substantially coextensive with the sides of the combustion chambers, with its upper end terminating substantially at the level of the tops of said combustion chambers and operating to draw water from the bottom of the boiler and to discharge the same adjacent the top ends of the combustion chambers.

1,861,388. FIRE BRIDGE. CARL HEINRICH GREVE, OF ALTONA-ON-ELBE, AND WALTER CHRISTIAN DETLEF SCHWARZ, OF HAMBURG, GERMANY, ASSIGNORS TO THE FIRM OF ROLFS KOHLEN-OXYD-VERBRENNER GESELLSCHAFT MIT BESCHRANKTER HAFTUNG, OF HAMBURG, GERMANY.

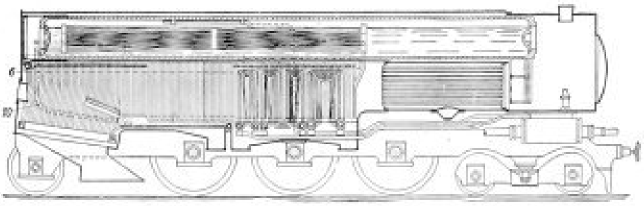
Claim.—A fire bridge for furnaces comprising a support having an aperture therethrough, a casting mounted upon said support having



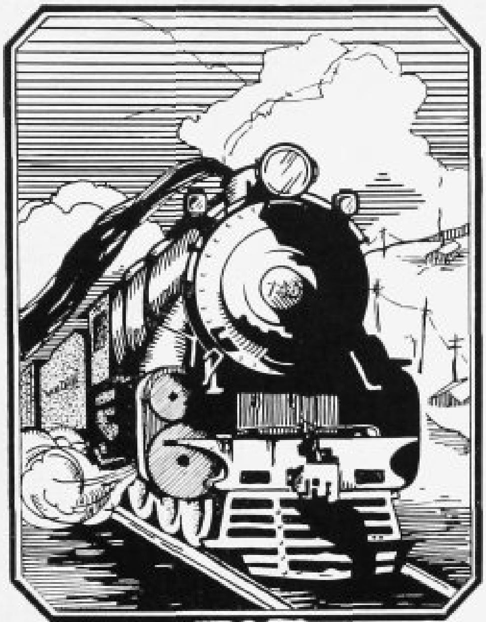
passages therethrough oblong in cross-section and communicating with said aperture at their lower ends and opening out at their upper ends approximately at right angles to the direction of the gases of combustion, the walls of said passage being twisted about the approximately vertical center line of the passage.—Three claims.

1,858,143. SUPERHEATER INSTALLATION. OTTO ENGLER, OF KASSEL-WILHELMSHOHE, GERMANY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y.

Claim.—The combination with a locomotive having a frame including



longitudinal beams, wheel axles, a boiler provided with a fire box and an adjoining flue having walls formed of water tubes, of a superheater group having tubes extending into said flue and having headers lying at the bottom of the flue, said superheater group having dimensions of such relation to those of the locomotive frame that it may be moved between the longitudinal beams of said frame clear of the locomotive wheel axles, whereby the superheater group may be inserted and removed while the locomotive wheel axles are in position. Nine claims.



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Practical Plate Development Series

As announced in the February issue, the first of a new series of articles, entitled "Practical Plate Development," by George M. Davies, is published in this issue. The work is undertaken with the sole idea of providing what is believed to be a worthwhile educational service to our readers.

The appeal for this type of information is extremely wide in the boiler making and plate fabricating fields and is not in any sense confined to those actually engaged in laying out work. The designers, particularly the younger members of the profession, who may have acquired their knowledge of laying out from the theoretical treatment embodied in applied geometry, will find of value an understanding of the principles of plate development as actually practised in the shop. Those who wish to follow the laying out trade will also find to be worth while the time spent in studying the solutions given to specific problems, as well as the facility which may be achieved by carrying through the practice layouts published with each article.

To the experienced layerout the explanations and examples given may not offer anything particularly new in the way of information. On the other hand, new methods may be described in the course of the series which will be helpful and from which may be derived great benefit. Whether or not such specific help may be gained, it is always beneficial to study a variety of methods in the attempt to broaden knowledge within a trade or profession. From the author's standpoint, the criticisms and suggestions which experienced layerouts may send to him will be helpful in making the articles of greater interest to the entire field.

Finally, there is the very large group of those engaged in the fabrication of all manner of plate shapes produced on the laying out bench. To these individuals a working knowledge of the principles of laying out should be of tremendous assistance in producing in metal what the layerout has developed.

To an ever increasing extent, as the applications of plate fabrication grow broader throughout all industry, should this subject of laying out be of interest to these groups.

The practice example given with this article, and with all subsequent articles, presents an opportunity for applying the principles explained. If each one is carried through completely and later checked for accuracy with the solution which will be published, by the time the series has come to an end, a great many readers will find they have acquired a comprehensive education in laying out.

If in the course of the series any reader finds the explanations given incomplete or in error, he will do the author a distinct favor by calling such cases to his attention. In the solution of the practice problems should difficulties be experienced which cannot be cleared by a study of the correct solution published two months after, the reader should write to the author in the care of this office for assistance.

Any question concerning boiler, pressure vessel, plate layout or other work pertaining to the field covered by Boiler Maker and Plate Fabricator can be submitted to the Questions and Answers Department at any time for solution or advice.

Future of the Steam Locomotive

Those whose lives have been largely devoted to the work of operating and maintaining the steam locomotives of the country have been given some concern during recent months by the widespread publicity occasioned by spectacular runs of Diesel-electric streamlined trains placed in service on a number of railroads. The article in this issue by R. P. Johnson on the relative advantages of steam and Diesel motive power should do much to allay the fear that the day of the steam locomotive is waning.

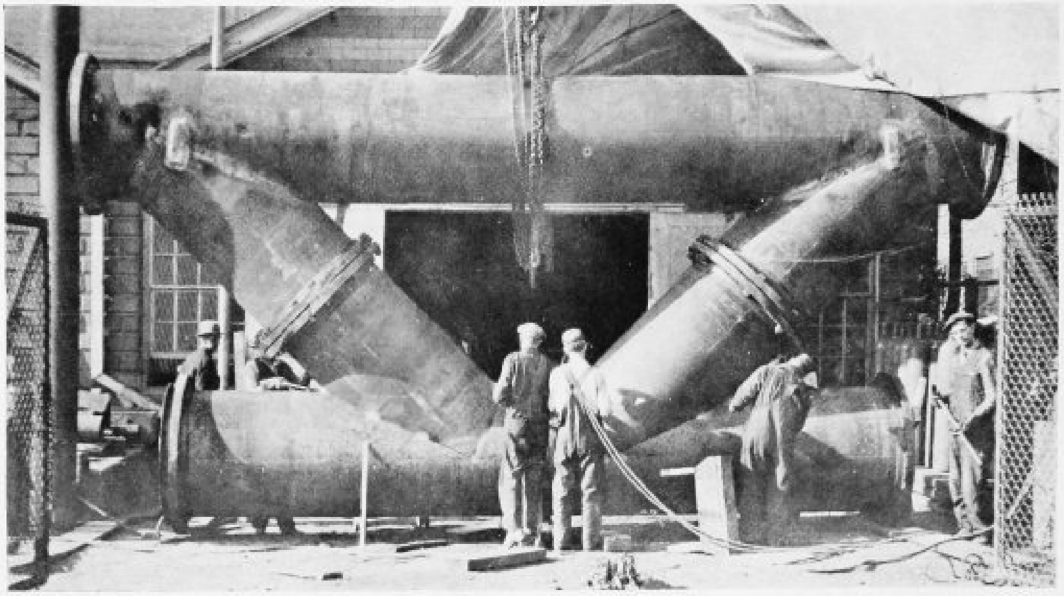
There are certain economic uses to which Diesel power may be put on the railroads, but these are greatly limited in extent. It is hardly conceivable within the generations now living that any wholesale replacement of steam power by internal combustion power will occur. Certainly there is no evidence that the factors now restricting the Diesel engine as a source of power will very readily be overcome nor that the replacement of obsolete locomotives will be made by other than steam.

In its favor the Diesel-electric unit offers high availability for service and at the present moment low fuel cost. Against it are higher first cost, lubricating oil expense, greatly expanded maintenance cost, high fixed charges and other items dealt with extensively in the article mentioned.

There is no guarantee that Diesel fuel costs will not increase in the future and long experience with Diesels in every type of service is necessary to determine with any degree of accuracy the relation of maintenance cost of the Diesel with that of steam power.

Undoubtedly there will be a further adoption of low-weight, high-speed Diesel-electric trains for special passenger service and an increase in the application of this power to switching engines. However, there is no evidence of any trend away from steam locomotives for the major part of the motive power of the country. On the other hand there is every indication that many of the favorable elements now embodied in the Diesel as a power source can be obtained in the modern steam locomotive by the use of special materials now available, by careful design and high efficiency specialty equipment.

In the next few years, during which a tremendous replacement of obsolete equipment must be undertaken, as well as the wholesale rehabilitation of a large proportion of existing motive power, there is every reason to believe that the steam locomotive will more than hold its own as the power source for the nation's railroads.



Fabricating a Y Section

PRACTICAL PLATE DEVELOPMENTS—I

Pipe Connections

By George M. Davies

This first article of a new series on laying out problems, which will continue for several months, deals with a form of layout work that covers a tremendously wide field of applications throughout all industry. The principles involved in making pipe connection developments of which the present example is typical should prove of interest to a large number of our readers. The articles are being written to supply the practical details necessary to a proper understanding of the subject. The author will welcome communications from any reader who experiences difficulty in applying the methods outlined. To stimulate interest among those who seriously wish to improve their knowledge of laying out, a practical problem will appear at the end of each article, the solution of which will follow closely the lines of development explained in the article that month. Full details for the first of these problems appear on page 62

Pipe lines and pipe installations often result in irregular connections such as illustrated in Fig. 1. This connection consists of a main pipe having a lead pipe of the same diameter as the main pipe and setting at 30 degrees to the axis of the pipe; the main pipe forming an elbow of less than 90 degrees at the end. The pipe is of welded construction.

To develop the patterns for the various parts of the connection, the first step is to lay out the elevation, Fig. 2, and plan view, Fig. 3, to the dimensions given in Fig. 1, using the neutral diameter of the pipe for the outline.

The first step in construction is to obtain the miter lines in the plan view of the elbow portion of the pipe. Erect a perpendicular to *M-N* through the center of the radius *O*, as *O-P* cutting *M-N* at *W*. Erect a perpendicular to *R-S* through *O* as *O-T* cutting *R-S* at *U*. Divide the arc *U-W* into one less than the required number of sections in the elbow, as *W-a*, *a-b* and *b-U*. The number of sections in the elbow is taken as four; sections (*C*) and (*D*) as one each, and the end portions of each pipe inside of the arc *W-U* as one each.

Bisect arcs *W-a*, *a-b* and *b-U* and draw radial lines to the point *O* as *O-X*, *O-Y* and *O-Z*. These lines are the miter lines of the elbow.

Draw lines tangent to the arc *U-W* through the points *a* and *b*; these lines being the axis of the sections *C* and *D*. On *a-O* step off each side of *a* a distance equal to one-half the neutral diameter of the pipe as *a-c* and *a-d*. Erect perpendiculars to *a-O* at *c* and *d*, completing section *C*. In like manner on *b-O* step off each side of *b*, a distance equal to one-half of the neutral diameter of

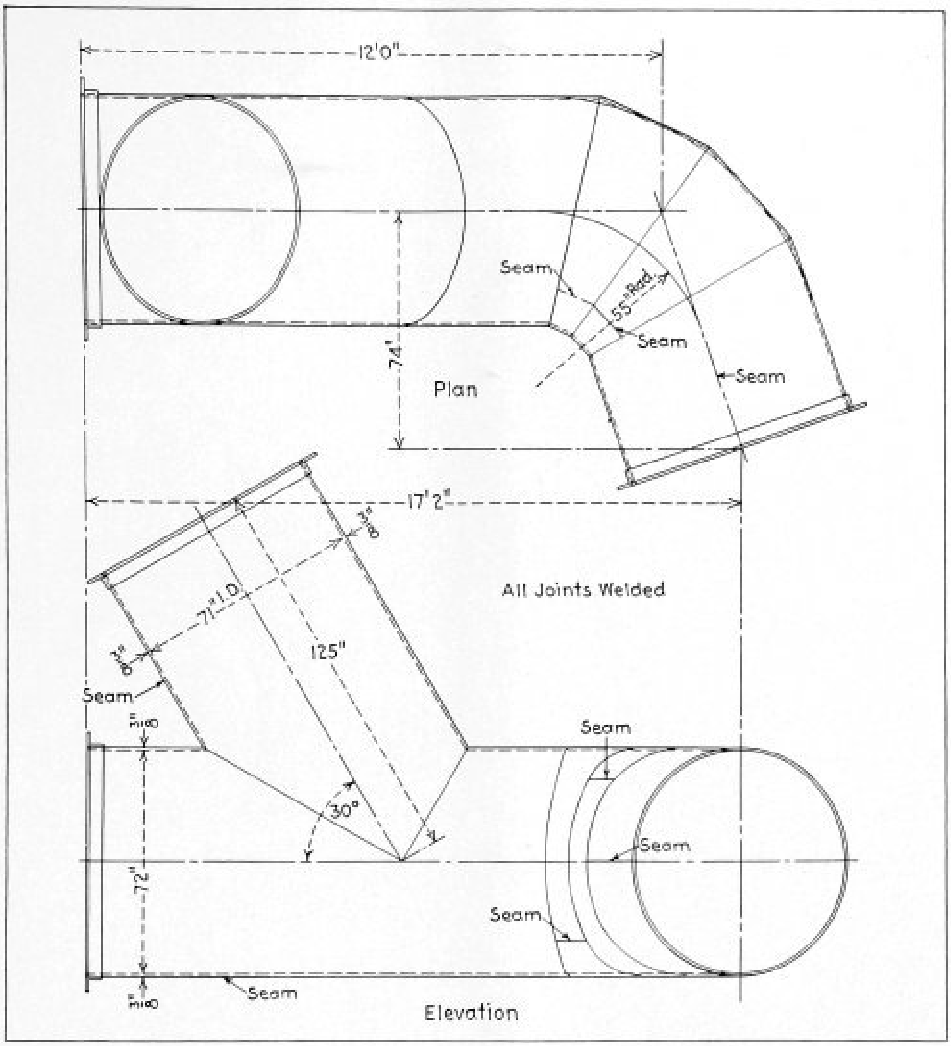
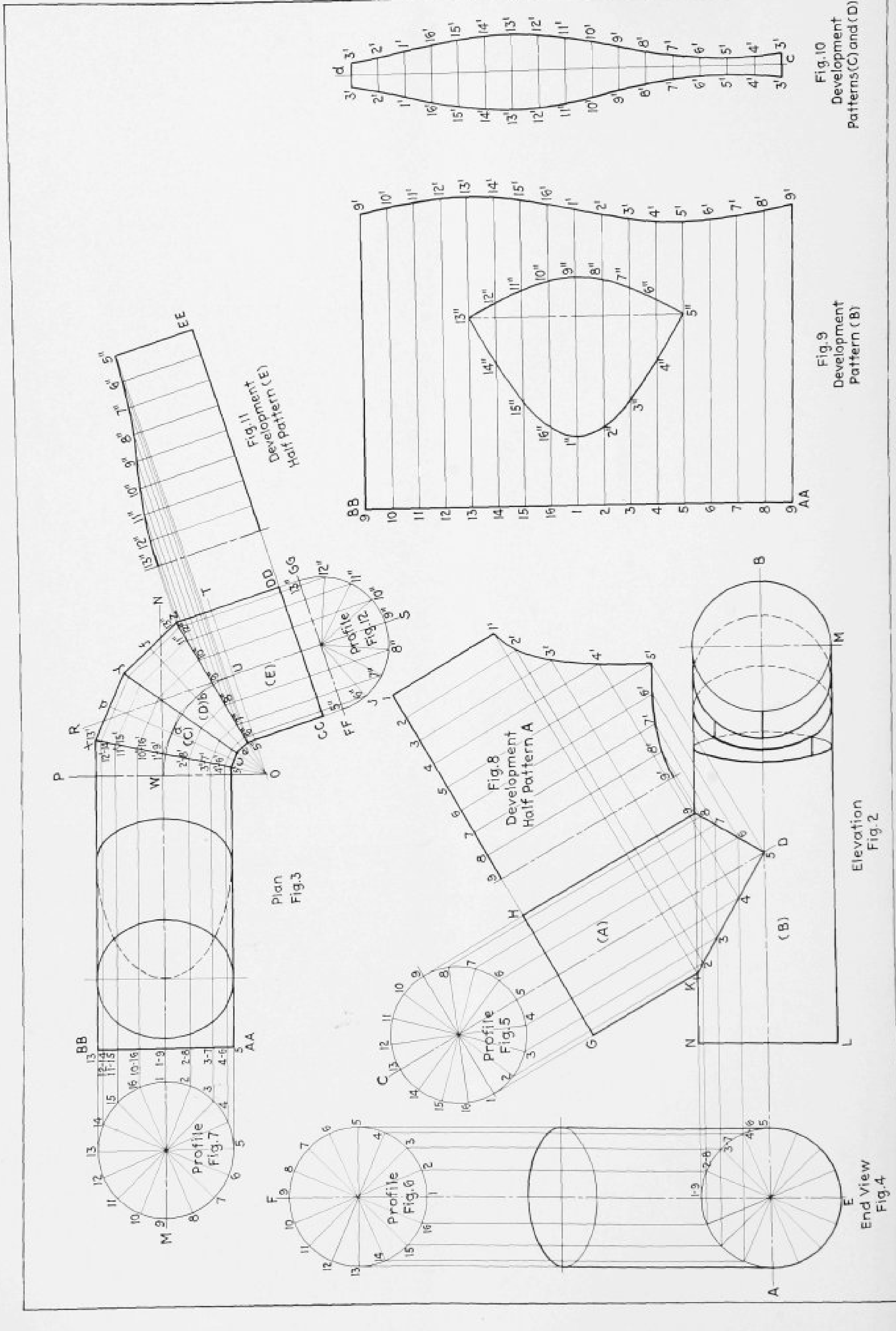


Fig. 1.—Elbow pipe connection with 30-degree offset outlet

Offset connection set up for welding. This is a typical application of the layout problem described



Figs. 2 to 12.—Layout of elbow pipe connection with 30-degree offset outlet the pipe as *b-e* and *b-f*. Erect perpendiculars to *b-O* at *e* and *f*, completing section *D*; thus completing the plan view.

The next step is to obtain the miter lines in the elevation between the lead pipe and the main pipe.

On the center line *C-D* construct the profile, Fig. 5. Divide the profile into any number of equal parts, sixteen being taken in this case. Number these divisions from *1* to *16* as shown; the greater the number of parts taken the more accurate will be the final development. Parallel to *C-D* draw lines through the points *1* to *9*, extending same into the elevation.

Next on the center line *E-F* of the end view, draw the profile, Fig. 6, and divide this into the same number of equal parts as was taken in profile, Fig. 5. Number the divisions corresponding to the divisions in profile, Fig. 5. Parallel to *E-F* draw lines through the points *1* to *9*, extending these into the end view cutting the circumference of the end view of the pipe *B*, Fig. 4, at the points *1-9* as shown. Then parallel to *A-B* through the points *1-9* draw a line cutting the lines drawn from points *1* and *9*, profile Fig. 5, parallel to *C-D*, locating the points *1* and *9* in the elevation, Fig. 2; in like manner draw a line parallel to *A-B* through points *2-8* cutting the line drawn from points *2* and *8*, profile Fig. 5 parallel to *C-D*, locating points *2* and *8* in the elevation Fig. 2. Continue in this manner until points *3*, *4*, *5*, *6* and *7* in the elevation, Fig. 2 are located. Connect these points with a line which will be the miter line between the pipes *A* and *B* in the elevation, Fig. 2.

Development of Pattern for Pipe "A"

The development of the pattern for pipe *A* is shown in Fig. 8.

The joint for pipe *A* is along the line *G-K*. It will be noted in the end view that the center line *E-F* divides the pipe *A* into two symmetrical halves, and therefore a development of one-half can be duplicated for the other half.

Extend the line *G-H* of the elevation as *G-J* and from any point on *G-J* as *1* step off the distances *1-2*, *2-3*, *3-4*, to *8-9*, equal to the divisions *1-2*, *2-3*, *3-4*, to *8-9* of the profile, Fig. 5. The distance *1-9* should be equal to one-half the circumference of the pipe *A* taken on the neutral diameter. Erect perpendiculars to the line *G-J* at the points *1* to *9* extending same down as shown. Then parallel to *G-J* draw a line through the point *1* of the elevation, Fig. 2, cutting the line drawn perpendicular to *G-J* at the point *1* on *G-J*, locating the point *1'*, Fig. 8. Continue in this manner locating the points *2'*, *3'*, *4'*, *5'*, *6'*, to *9'*, Fig. 8. Connect the points *1'* to *9'* with a line, completing the half pattern of the pipe *A*.

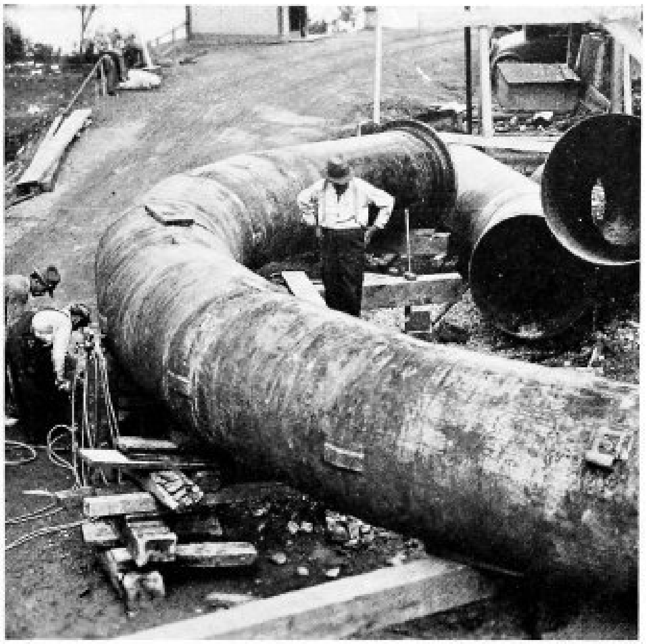
Development of Pattern for Pipe "B"

The development of the pattern for pipe *B* is shown in Fig. 9.

The joint to pipe *B* is along the line *L-M*, Fig. 2.

On the center line *M-N* of the plan, Fig. 3, draw the profile Fig. 7. Divide this profile into any number of equal parts, sixteen being taken in this case; number these divisions from *1* to *16* as shown. The greater the number of parts taken the more accurate will be the final development. Parallel to *M-N*, draw lines through the points *1* to *16*, extending same cutting lines *AA-BB* and *O-X*. Number these from *1* to *16* on *AA-BB* and from *1'* to *16'* on *O-X*.

Draw a line as *AA-BB*, Fig. 9, and step off sixteen spaces equal to the spaces taken in the profile, Fig. 7. Number these divisions from *1* to *16* in the manner shown. The distance *9-9*, Fig. 9, should be equal to the circumference of pipe *B*, taken on the neutral diameter.

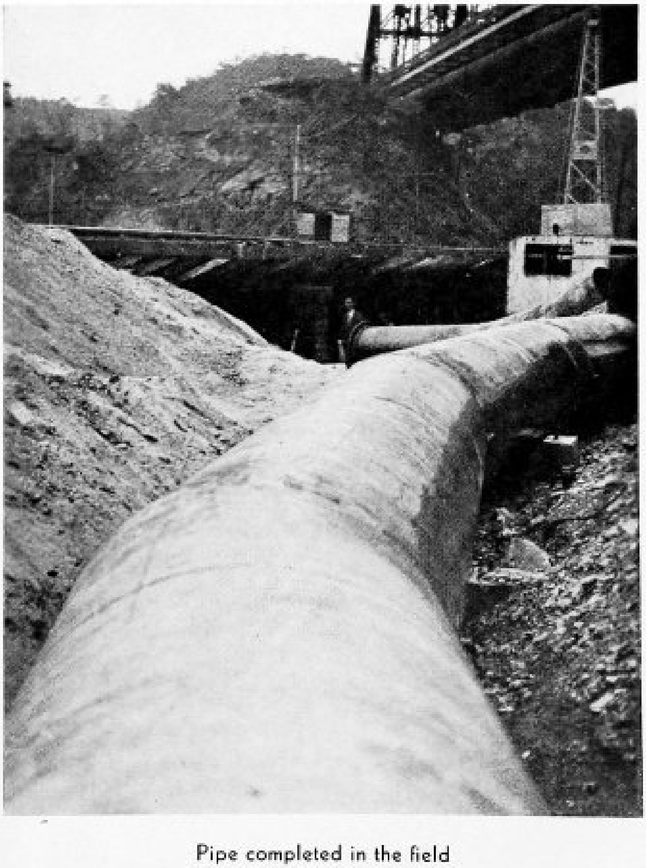


Elbow section of pipe ready for welding

Erect perpendiculars to *AA-BB*, Fig. 9, at the points *1* to *16* as shown.

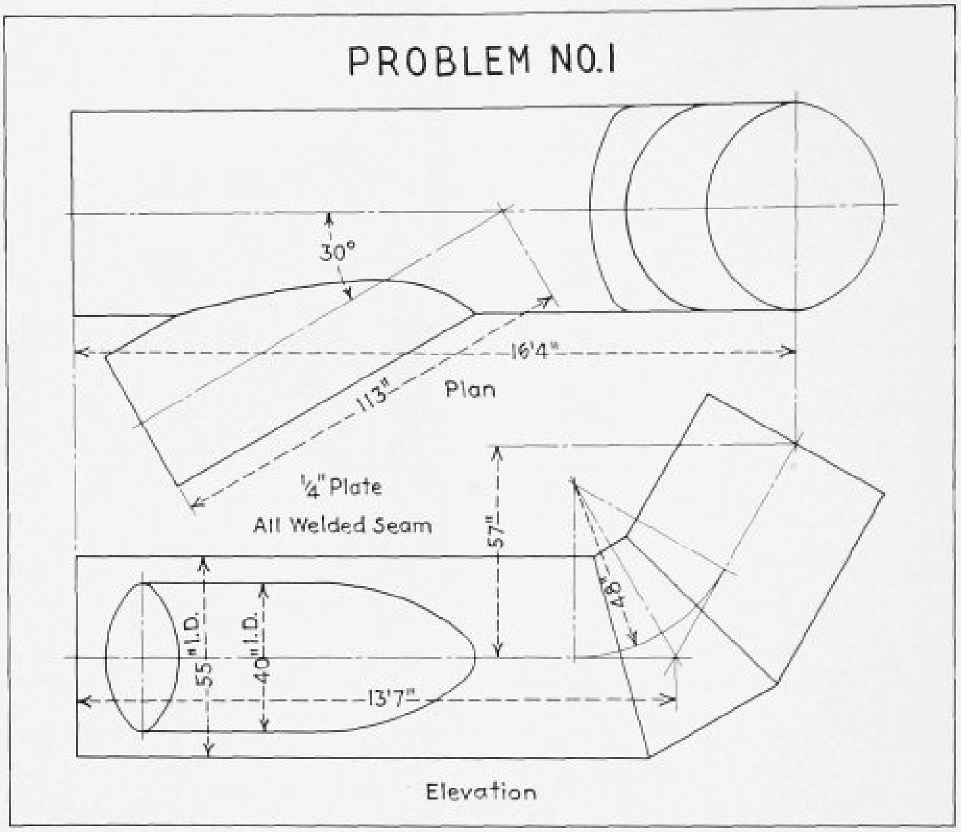
On the perpendicular to point *1* step off the distance *1-1'* equal to *1-1'* of the plan view, Fig. 3. On the perpendicular to point *2* step off the distance *2-2'* equal to *2-2'* of the plan. Continue in this manner until the points *3'* to *16'* of the pattern, Fig. 9, are located. Connect the points *9'* to *9'* with a line completing the outline of the pattern for pipe *B*.

The next step is to lay out the hole in the pattern *B*, Fig. 9, for the intersection of pipe *A*.



Pipe completed in the field

Problem No. 1—For Readers to Lay Out



Problem No. 1 is a pipe connection similar to the foregoing development. The differences are sufficient, so that a clear understanding of the methods used will be required to carry the development through correctly. This problem is given for interested readers to develop by themselves. In the May issue the correct development will be published, which may be used to check the accuracy of individual layouts. If, at that time, any reader experiences difficulty in following the method or requires further explanation on any part of the layout, he is invited to submit his questions to Mr. Davies through this office for help in clearing up any points which may occur

Due to the fact that the two pipes are of the same diameter and the same number of divisions have been taken for both pipes, the same spacing can be used for the development of the hole as was used for the development of the pattern. Where the diameters of the pipes are different, the spacing for the hole would have to be taken equal to the spacing used for pipe *A*.

On line *1-1'*, Fig. 9, step off the distance *1-1"* equal to the horizontal distance from the line *L-N* to the point *1*, Fig. 2, and the distance *1-9"* equal to the horizontal distance from the line *L-N* to the point *9*, Fig. 2. In like manner locate the points *2"* to *8"*, Fig. 9. Then step off *16-16"* equal to the horizontal distance from the line *L-N* to the point *2*, Fig. 2, and in like manner *16-10"* equal to *L-N* to *8*, *15-15"* equal to *L-N* to *3*, *15-11"* equal to *L-N* to *7*, etc., until all the points from *1"* to *16"*, Fig. 9 are located. Connect these points with a line, completing the cutout for pipe *A*, thus completing the development.

Development of Pattern for Elbow Sections "C" and "D"

The development of the pattern for the elbow sections *C* and *D* is shown in Fig. 10.

It will be noted in the plan due to the method of developing the miter lines that the sections *C* and *D* are identical and by arranging the welded seam so that on one section it will be exactly the same distance above the center line of the pipe as it is below on the other section one pattern can be used for both sections. The seams taken at the points *3'* and *7'* will meet this condition.

Draw any line as c'-d', Fig. 10, and step off sixteen equal spaces equal to the spaces taken in the profile, Fig. 7. The distance c'-d', Fig. 10, should be equal to the circumference of the elbow section *C* taken on the neutral diameter. At each of the points erect perpendiculars to c'-d', extending same on both sides of c'-d', as shown in Fig. 10.

Next step off the vertical distance from the line *c-d*, Fig. 3, to the point *3*, each side of the center line c'-d' locating the points $3'$-$3'$, Fig. 10. In like manner step off the vertical distance from the line *c-d*, Fig. 3, to the points $4'$, $5'$, $6'$, $7'$, to $16'$ to $3'$ each side of the center line c'-d', Fig. 10, locating the point $4'$-$4'$, $5'$-$5'$, $6'$-$6'$, to $16'$-$16'$ to $3'$-$3'$ as shown. Draw a line through the point $3'$-$16'$-$3'$ on each side of the center line c'-d' completing the pattern of the sections *C* and *D*.

Development of Pattern for Section "E"

The development of the pattern for pipe *E* is shown in Fig. 11.

On the center line *R-S*, Fig. 3, draw the half profile Fig. 12. The profile being a circle. The center line *FF-GG* divides the object into two symmetrical halves and therefore a development of one-half the pattern is all that is required.

Divide the profile into eight equal parts, one-half the number taken in profile, Fig. 7. Number the divisions from $5''$ to $13''$ corresponding to *5-13* of profile, Fig. 7.

Parallel to *R-S* draw lines through the points $5''$ to $13''$ extending same cutting the line *O-Z*, at $5''$ to $13''$ as shown.

Extend the line *CC-DD* to *EE*. Step off eight equal spaces equal to the eight divisions taken in the profile, Fig. 12, and at each division erect a perpendicular to the line *CC-EE*. Then parallel to *CC-EE* draw lines through the points $5''$ to $13''$, Fig. 3, extending same into the pattern, Fig. 11, cutting the perpendiculars to the line *CC-EE*, locating the points $5''$ to $13''$ Fig. 11, as shown. Connect these points with a line completing the half pattern of *E*. A duplicate of this pattern will complete the full development of the section *E*.

Assembling

The patterns shown do not make any provision for welding the seams. The practice is to bevel the edges of the plates and to provide a gap between the plates after they are rolled for making the welds. Allowance should be made in the length and width of the plates and edges of the developed plates should be machined for the type of weld required.

(To be continued)

Roughing Floor Plates with the Torch

Sure footing, important to all factories and plants where employees are passing to and fro in the course of their work, is always a highly important factor. The use of plain flat steel plates for truckways, door sills, loading dock toeboards is general in all practice. Scrap material that would otherwise be junked is often used. Becoming slightly worn, these plates often get a highly polished surface and become very slippery, especially when oily, greasy, wet, or under winter or outdoor conditions. These can be roughened up very nicely with the use of the oxy-acetylene blowpipe flame.

Hold the flame on the steel plate in one spot until the spot just melts, then rapidly remove the flame. Do this in as many spots on the plates as necessary to give sufficient roughness. The small indentations with the rough hard edges of these artificial pit marks, constitute a long wearing roughness of just the right amount to prevent slipping—even when pushing a heavy loaded hand truck. The pit marks might well be spaced about one inch apart in both directions, either in straight rows or alternate rows.

Certain advantages of this method are as follows: a roughened non-slip surface can be created in a few minutes at short notice with small expense; a plate can be treated while in place—one reason for the low cost—or without removing it from service, even temporarily; the surface can be made with any degree of roughness to suit demands or conditions. This is an idea worth trying out.—*Oxy-Acetylene Tips.*

Electrodes for Vertical and Overhead Welding

Welding in the vertical and overhead position involves the use of welding rods which are particularly designed for that purpose, if the minimum degree of sensitivity to unfavorable welding conditions is to be obtained. The welding rod marketed under the trade name "Blue Devil" by the Champion Rivet Company, Cleveland, is designed particularly for vertical and overhead welding and other applications where conditions are unfavorable.

Those who are familiar with the operator's technique in such welding operations are aware of the fact that it is necessary for him to distribute the heat from the welding arc to a sufficient degree to avoid formation of a pool of molten metal of high liquidity. The molten weld metal stays where it is put by the operator only because the force exerted by surface tension tending to hold it there is greater than the force exerted by gravity which tends to pull the molten metal out of the pool. The operator's technique is such, in successful welding, that he keeps the temperature of the weld metal in the pool or crater down to such a point that the metal will stay where it is put. Since the operator cannot control the temperature of the arc, he accomplishes this purpose by distributing the molten metal from the electrode over a sufficiently wide area to permit the cold parent metal to absorb enough of the heat from the weld metal to keep it below the critical temperature at which it would run out of the crater.

A technique to accomplish the above stated purpose necessarily involves swinging the welding electrode, during welding operation, in some kind of a pattern of movement. Different operators use different patterns and the result may be successfully obtained in several different ways.

Swinging of the electrode through various patterns to do vertical or overhead welding complicates the problem of providing a suitable welding rod for such work. The arc length and current value both vary between wide limits during the execution of such patterns. The skill of the operator is therefore an important factor. In manufacturing and construction operations, it is usually impossible to have all welding done by highly skilled operators. There are not enough of such operators available. The extent to which the welding rod manufacturer can de-sensitize the welding rod to unfavorable welding conditions is a measure of its utility in manufacturing and construction welding operations involving vertical, overhead and non-position welding.

While mineral coated welding rod is shown by experience to be the least sensitive to improper welding

Report of Metallurgical Department

PHYSICAL PROPERTIES—CLASS 1

Purchaser: The Champion Rivet Co.
Address:
Order No.: Regular Shop Test
Manufacturer: Address:
Mfgrs. Designating No.: W (Brand) (Serial) Test No.: 469 (Date) B. D. (Serial) Date of Test: 10/16/34
Welding Operator—Name: F. M. W. Number:
Tested By: Reason for Test: Inspection
Plate Thickness: 1" Plate Specification: A. S. M. E.
Type of Weld: flat Kind of Welding Wire: Blue Devil Type of Welding Groove: U
If Stress relieved, describe:

REDUCED SECTION TENSILE TEST

Specimen No.	Dimensions: Width	Dimensions: Thickness	Area	Total Load, Lbs.: Yield Pt.	Total Load, Lbs.: Ultimate	Unit Stress, Lbs. Sq. Inch: Yield Pt.	Unit Stress, Lbs. Sq. Inch: Ultimate	Character of Failure and Location
	1.48	.83	1.23	56210	82630	45 700	67200	Broke in weld-2 small gas pockets

.505" ALL-WELD TENSILE TEST

Specimen No.	Dimensions: Width	Dimensions: Thickness	Area	Total Load, Lbs.: Yield Pt.	Total Load, Lbs.: Ultimate	Unit Stress, Lbs. Sq. Inch: Yield Pt.	Unit Stress, Lbs. Sq. Inch: Ultimate	Character of Failure and Location
	.506		.2011	10680	13920	53300	69 500	Silky structure no flaws ¼ cv-

Elongation $= \frac{E_1 - E \times 100}{E} = \frac{2.52-2}{2} = 26\%$

Reduction of Area $= \frac{A - A_1 \times 100}{A} = \frac{.506-.365}{.506} = \frac{.2011-.1046}{.2011} = 48\%$

FREE BEND TEST

Specimen No.	Gage Length: Before Bending	Gage Length: After Bending	Difference	% Difference	Remarks
	1.03	1.45	.42	40.7	No flaws

SPECIFIC GRAVITY TEST

Specimen No. $\frac{W}{W - W_1} = \frac{35.98}{35.98-31.39} = 7.847$ Remarks

Result of tests on Blue Devil Electrodes

conditions when the welding is done in the downward position, mineral coated welding rod, with the present knowledge of how to make it, is extremely sensitive to the difficult conditions encountered in vertical or overhead welding. The shielding and fluxing of the molten metal of the weld crater in the vertical or overhead welding positions must be effectively done in spite of the pull of gravity which tends to make the slag run off the molten crater. Since the mineral coating accomplishes the shield largely by mechanical enclosure of the arc and crater, it is obvious that difficulties would be encountered in the vertical position. Shielding for welding rod to be used in the vertical position, therefore, is accomplished by the addition of volatile matter to the rod coating. This volatile matter furnishes an envelope of gas around the arc and molten crater preventing atmospheric contamination. As much fluxing material as will be held on the molten metal by surface tension is included in the covering. Sufficient gas envelope must be provided to cover the metal at the point in the swing of the electrode at which the arc is longest and enough fluxing material must cover the molten metal at such times as it may be uncovered by the gas envelope.

The net result of such compromises as must be made to get complete shielding and fluxing of the weld metal when welding in the vertical or overhead position is that more skill on the part of the operator is required than in the case of downward welding. This is in accordance with the experience of most welding departments which employ a considerable number of welding operators.

It is of course, true that a welding rod which is designed primarily for vertical or overhead welding may be used for downward welding. However, more skill is required to use the rod designed for vertical welding on downward welding than a properly made all mineral coated rod designed particularly for downward welding.

The Blue Devil welding rod is made in all sizes and is recommended for vertical and overhead welding and may of course be used for downward welding. Special care has been used in the designing of its coating to reduce undercutting and splatter which are characteristic of rods of this type. The physical properties of the weld metal come well within the requirements of the A.S.M.E. code. Tensile strength runs 65,000 pounds to 68,000 pounds per square inch; elongation 25 to 30 percent; density, 7.85 specific gravity.

RECOMMENDED PROCEDURE IN THE USE OF BLUE DEVIL ELECTRODES

(Reverse polarity is desirable)

Diameter—Inch	Amperes	Voltage
1/8	75—120	30—35
5/32	110—160	30—35
3/16	170—210	35—40
1/4	220—300	37—45
5/16	290—400	40—47
3/8	400—550	45—50

The electrode should be pointed as to form an angle with the work. The degree of the angle will vary with the type of welding being done. The position of the electrode with reference to the work is different in making fillet welds than in welding in the vertical or overhead positions.

Vertical welding is only practical when rods 1/8, 5/32, or 3/16 inch in diameter, and for this type of welding current values are recommended approximately 20 percent less than those shown in the above table.

German Steam Boiler Industry Displays Activity

By James H. Wright*

Interesting data concerning the activities of the German steam boiler industry during the past two or three years were revealed in the course of a lecture recently delivered at Essen, Germany, by Dr. Friedrich Schulte, president of the Association for the Supervision of Power Equipment in the Ruhr coal mines. From Dr. Schulte's speech it would appear that the German steam boiler industry has made considerable progress of late.

It was set forth that the economic depression had sorely tried the German steam boiler industry, but that the idle time thus made available had been utilized for the extension of research work with a view to improving the products of manufacture of the German boiler industry. The results of this research work have been characterized as highly satisfactory.

Several of the improvements stated to have been made in the course of the research work are of interest. Considerable success would seem to have been enjoyed in the field of the production of high pressure equipment, embodying increased efficiency. In this connection special steels with high tensile strength have been used. While water gas welded equipment predominates, electrically welded equipment is stated to be gaining ground, while riveting has almost disappeared. The general tendency has been one of simplification of boilers and equipment. This simplification is claimed to have been carried so far that efficient high pressure boilers now cost but little more than low pressure boilers. Special attention in general has been given to the subjects of water circulation, water cooled fire chambers, draft control, and the rolling of smooth boiler drums from hollow blocks.

* American vice-consul, Cologne, Germany. Information released by the Department of Commerce, Bureau of Foreign and Domestic Commerce.

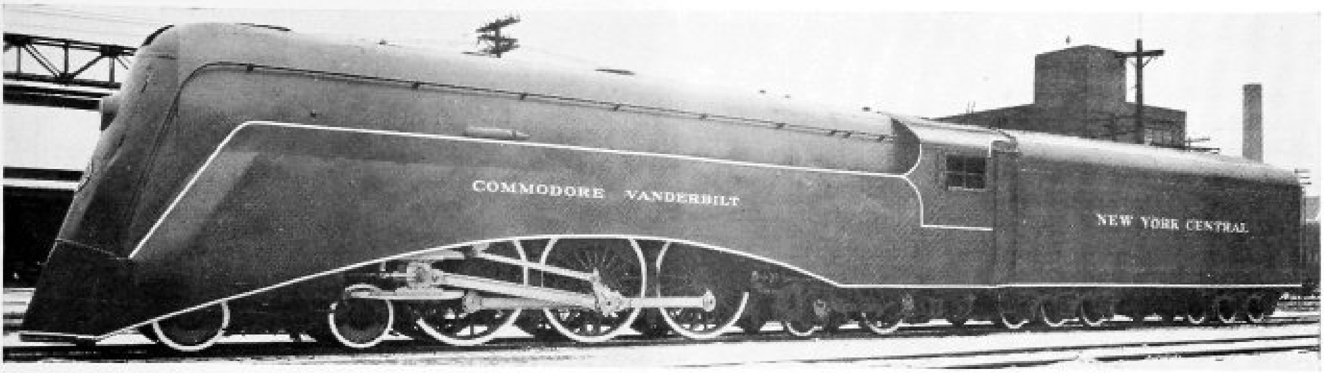


Fig. 1.—The steam locomotive offers opportunities for stream-lining

Will motive power of the future be

STEAM OR DIESEL*

By R. P. Johnson

Due to the fact that many lightweight high speed passenger trains are powered by internal combustion engines, it is assumed by some that the realization of speeds around 100 miles per hour is dependent on this type of power. This, of course, is not true. The only factor that allows a 600-horsepower internal combustion engine to compete with a 1000 to 4000 horsepower steam locomotive, is that of the tons handled. Steam locomotives of the 1890's could produce more speed than the high-speed internal combustion units of today, if given the same load to haul. Thus, for instance, locomotive No. 999, which pulled the *Empire State* express of the New York Central more than 40 years ago, made a speed of 112 miles per hour, and high speed locomotives used by the Reading Railroad for its service to Atlantic City made speeds of 115 miles per hour. There is nothing inherent in a steam locomotive to limit its speed. That the railroads have not availed themselves of this speed is due to other practical considerations as detailed previously. The fundamental problem in raising passenger service speeds is to decrease the dead weight of the cars which constitute the train.

The effect of streamlining is not confined to internal-combustion powered trains and can be used to advantage and is as readily applicable to steam trains.

To compete with the steam locomotive economically, the Diesel-powered unit should become a separate unit and not an integral part of a train. When part of a train, it is not flexible, as the units are not interchangeable with any other passenger equipment. If any portion of the unit is out of commission, the entire investment in the unit is out of service. These units are rigid in their capacity and can neither be increased nor diminished to meet the changing requirements of travel from day to day and from season to season. The same rigid limitation exists upon the motive power unit as upon the train as a unit and even if it were possible to expand the size of these trains at periods of peak demand, the rapid decline at speed of the tractive force of Diesel power would soon exhaust the ability of the Diesel unit to perform its schedule.

The internal combustion engine, which has the highest thermal efficiency of any type of prime mover, is unable to run at low speeds and has a low starting torque. A clutch gear arrangement is difficult to adapt to outputs of over 300 horsepower and consequently electrical transmission is generally used between the engine and the driving wheels. This is expensive and accounts for the high cost of internal combustion powered trains.

All the high-speed, light-weight, Diesel-powered trains to date are used for light passenger service. Due to the rapid fall in tractive force with increase in speed of the internal combustion engine, it seems improbable that it will ever be used for high-speed freight service. The same limitation applies where traffic requires a number of passenger cars on each train. If only 75 to 125 passengers are to be handled on a specific run, the problem from the viewpoint of power required, is simplified, as the weight in two or three coaches can be reduced to the point where the internal combustion locomotive can handle it at high speeds. Where density of traffic requires trains carrying six and eight cars with 400 to 500 passengers per train, the limitations in tractive force at high speeds of the internal combustion locomotive becomes very prominent.

A modern steam locomotive with high wheels, high boiler pressure and high superheat can haul eight or ten modern steel coaches of conventional design at any speed required. If the engine and train are streamlined, as are the internal-combustion-powered trains, the power required at high speeds is decreased and a smaller locomotive can be used. The modern steam locomotive,

* Abstract of an article analyzing the relative advantages of modern power, as published by *Baldwin Locomotives*.

due to its better boiler design, is capable of maintaining its effective drawbar horsepower up to higher speeds than older designs and, therefore, in considering the relative merits of internal combustion and steam only modern types of steam power should be used.

Very little attention has been paid to decreasing the weight of the steam locomotive, but for maximum economy this matter should be given consideration, while at the same time retaining as far as possible the well proved components of ordinary locomotive practice, such as low first cost, low maintenance, reliability, safety, high horsepower at speed, and capability of being operated and maintained with present railroad facilities and organization.

The main advantage of the internal combustion powered train is in its initial acceleration, which is at the rate of 3 to 4 miles per hour per second against 0.2 to 0.5 miles per hour per second for steam locomotives.

The steam locomotive by refinements in design, which would decrease the weight, could be built to provide a starting acceleration of one mile per hour per second. However, in comparing the "get-away" of steam and Diesel locomotives, the relative capacities at higher speeds must also be compared. The steam locomotive will pass all Diesel powered units at higher speeds, due to its ability to maintain a high power output.

Operating Costs

Granting that high speed trains are desired by a railroad, and that the relative advantages of steam and internal combustion powered trains from the viewpoint of acceleration and maintenance of speed have been considered, the next item of interest is cost of operation. There are many ways of calculating this and care should be exercised that all items affecting these costs should be included. For instance operating costs are listed by the I. C. C. as fuel, water, lubricants, other supplies, engine house expense and locomotive repairs. These constitute pure operating costs, but in considering the relative merits of two propositions, the statement should also include crews' wages, interest charges on the capital investment, amortization and taxes and insurance. A proper operating cost statement should be constituted as follows:

1. Fuel
2. Water
3. Lubrication
4. Other supplies
5. Engine house expense
6. Crews' wages
7. Locomotive repairs
8. Interest on book value
9. Amortization
10. Taxes and insurance

The first six items in the above list are constant costs, that is, they will be the same regardless of the age of the locomotive. Nearly every railroad has the cost per mile of these items.

The method of analysis is aptly demonstrated by an explanation of item No. 7, of special interest to our readers, namely, locomotive repairs.

Average Trend of Repair Costs

Age	*Repair Cost per mile*	*Age*	*Repair Cost per mile*
1	$.12	11	$.35
2	.20	12	.36
3	.26	13	.37
4	.28	14	.385
5	.29	15	.395
6	.30	16	.405
7	.31	17	.42
8	.32	18	.43
9	.33	19	.44
10	.34	20	.45

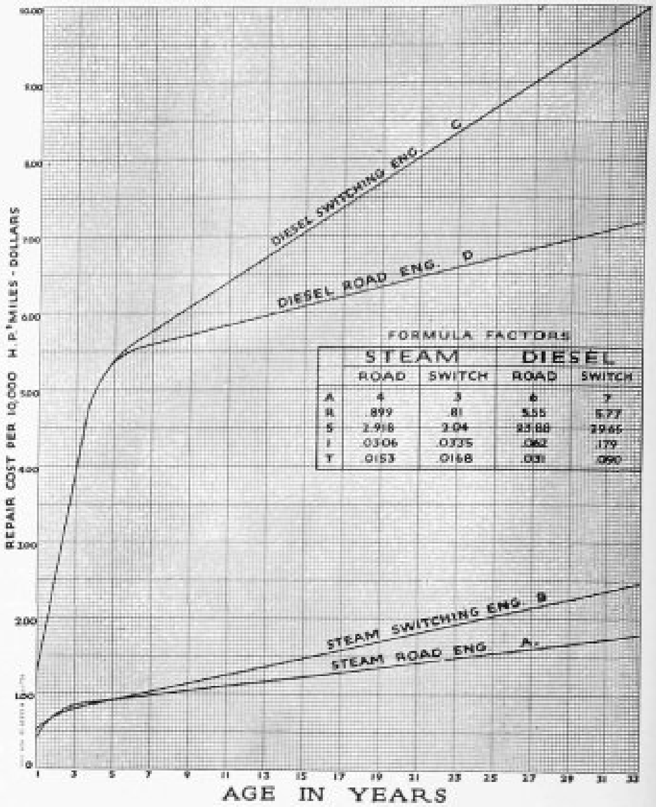


Fig. 2.—Repair costs of steam and Diesel power for various services

Repair cost studies on 16 United States trunk lines have shown a steadily rising cost with advancing age of power. This has been explained elsewhere, but an average trend of the repair costs determined from a study of 10,983 locomotives shows a rapid rise from the first to the third year and from then on a gradual increase (see Fig. 2). For a steam locomotive of 3000 potential horsepower, the repair costs per locomotive mile, based on the average trend mentioned, are as shown at the bottom of the left-hand column.

These costs per mile can be obtained for a steam locomotive of any horsepower by multiplying the cost per horsepower unit shown in the average cost trend curve by the potential horsepower of the locomotive in question and dividing by 10,000.

The maintenance costs of internal combustion powered road locomotives have not as yet been established due to the newness of this type of equipment. We have however, a reasonably accurate repair cost trend line for internal combustion switching locomotives based on information furnished to an American Railway Association committee. From the above-mentioned study of steam locomotive costs, we know that the maintenance of steam switchers is greater than for steam road engines. We have therefore plotted in Fig. 2, the cost of repairs for steam road engines (Curve A), steam switch engines (Curve B), and for internal combustion switch engines (Curve C). Curve D, for internal combustion road units was drawn the same percentage under the internal combustion switcher curve as the steam road engine curve is under the steam switcher curve. This may be used for calculating purposes.

Having a repair cost trend for both types of power, the average annual cost of repairs over their economic lives may be determined from the formula:

TABLE 1.—AVERAGE ANNUAL OPERATING COSTS FOR STEAM EQUIPMENT AND INTERNAL COMBUSTION UNIT FOR A SERVICE OF 110,000 MILES PER YEAR

Cost Item	*Column 1* Steam Economic Life 13 Years	*Column 2* Internal Combustion Economic Life 24 Years	*Column 3* Internal Combustion Assumed Life 15 Years
1. Fuel	$11,646.00	$7,920.00	$7,920.00
2. Water	315.00	....	....
3. Lubrication	550.00	2,200.00	2,200.00
4. Other Supplies	330.00	330.00	330.00
5. Engine-house Expense	**1,460.00**	**730.00**	**730.00**
6. Crews Wages	16,500.00	16,500.00	16,500.00
7. Maintenance	43,241.00	119,115.00	109,388.00
8. Interest Charges	8,942.00	13,021.00	13,333.00
9. Amortization	17,692.00	20,833.00	33,333.00
10. Taxes and Insurance	2,550.00	3,750.00	3,750.00
Total	$103,226.00	$184,399.00	$187,484.00
Cost per Mile	$0.938	$1.676	$1.704

In setting up an operating cost comparison, it should properly be the cost for maintaining a service and not one train. For one round trip a day every day in the year at least two motive power units should be available. The cost per mile for this service would then be double that shown above, which is for one train.

$$\text{Average Annual Repair Cost} = \frac{U\ (S + RN - RA + TN^2 + TN - 2\ TNA - TA + TA^2)}{N}$$

where: N = Economic life.
U = Average annual H.P.U. performance of locomotive.
A, R, S and T from repair cost trend curve (Fig. 2).

The results of exhaustive studies into all the factors mentioned are summarized for typical steam and Diesel power in Table 1.

This table lists the values and shows how a railroad can calculate the comparative annual average operating cost of high-speed service with either steam or internal combustion power. Unlike switching service where there is a great deal of stand-by time and a low load factor, this high-speed service requires continuous operation at a high load factor which accounts for the high fuel cost of the internal combustion train. The greater initial investment in the internal combustion train accounts for its higher interest charges.

The only item in the above statement that might form a basis for argument is the cost of repairs for the Diesel-powered units. We have assumed it in a manner which seems reasonable. The restrictions of locomotive size require that such engines operate at high speed and we know the maintenance cost of high speed internal combustion engines is high. The life of airplane engines is calculated in hours. Also it must be noted that the repair cost shown is the average annual cost over the economic life of the locomotive. In a life of 24 years the motive power unit certainly will require extensive if not complete replacement. Further, the maintenance of this high speed service is much more severe than that of any other type of service to which Diesel engines have been applied. In any case, it is conceded that their maintenance costs will be higher than steam. How much more, anyone is entitled to estimate for himself in drawing up an operating cost statement.

Such a statement gives a clear picture of the costs of the services as viewed from an engineering and accounting viewpoint but does not attempt to evaluate the advertising value of the new types of high speed trains.

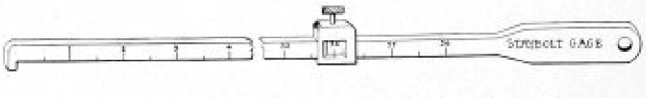
It should be clearly understood that Columns 1 and 2 are based on an economic life of the equipment which will give the lowest average annual operating cost. In other words the economic life is that number of years service during which the total cost of locomotive operation, including the amortization of the investment, reaches its lowest yearly average cost.

The two factors that determine economic life are the decreasing annual amount required for amortization and the increasing cost of repairs. If anyone does not agree that repair costs rise with increasing age, or believes that the rise will be at a lower rate than shown in Fig. 1, then the economic life of the equipment will be lengthened over that shown above.

The intent of this discussion is to show the proper method of setting up a comparative statement of operating expense, based on sound principles, and not to press any claims or values for the separate items. Each problem must be evaluated on its merits, and if fairly handled, we believe will show the high speed steam train to be more economical than internal combustion. As far as catering to public favor through streamlining, the steam locomotive and cars can be made quite as bizarre looking as any high speed internal combustion train.

Simple Gage for Length of Staybolts*

The staybolt gage shown in the illustration can be made from a piece of ½-in. by ⅛-in. sheet steel and with it only one man is required to get the shortest possible length of staybolt. By using the shortest bolt allowable waste of both material and time are avoided. Because of the difference in the radius of the inside and outside sheets of the firebox, the staybolts become increasingly longer as the center of crown sheet is approached and as a consequence different lengths of staybolts have to be used. In using the gage the point



Gage for length of staybolts with allowance for heading on both ends of bolt

is entered through the holes in both sheets and hooked over the second sheet. The thumb slide is then pushed down to the sheet and the required length of staybolt to be used will then be visible through the opening in the thumb slide. The measurement shown allows for two and one-half threads for laying down on each end of staybolts.

Electrode Produces Self Hardening Deposit

A new hard surfacing electrode, which is designed for building up straight carbon steel, low alloy or high manganese steel surfaces to resist abrasion, is announced by The Lincoln Electric Company, Cleveland.

This new electrode, known as "Abrasoweld," will be found of particular value in such applications as restoring teeth, lips and bottoms of power shovels; lugs and treads of tractors; housings and impellers of centrifugal sand pumps; rock crushing equipment; agricultural machinery; gear and pinion teeth.

Abrasoweld electrode provides a deposit of abrasion resisting alloy of the self hardening type which surface hardens very rapidly under conditions of impact and abrasion. This type of deposit has definite advantages over that which shows its maximum hardness as deposited. The tendency of the deposit to chip off in service is eliminated. Unlike that of other electrodes, the Abras-

* An article submitted by a locomotive inspector who designed the gage described.

oweld deposit develops its maximum hardness only at the surface where it is cold worked. This leaves a strong tough core for resisting shock. In this respect, the Abrasoweld deposit is similar to high manganese steel, the only difference being that the metal is harder as deposited and increases in hardness much more rapidly. For example, moderate peening will increase hardness as deposited from 20-30 Rockwell C to approximately 50 Rockwell C. Weld metal produced by Abrasoweld must be ground to shape, as it cannot be filed or machined.

Added to these advantages the Abrasoweld deposit is more resistant to corrosion than high manganese steel. The deposit can be forged hot without materially altering its physical properties.

Abrasoweld electrode is made in $^3/_{16}$ inch size, 14 inches in length. It is used with reversed polarity with a current range of 125-200 amperes and 24-27 arc volts.

Work of the A. S. M. E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the code is requested to communicate with the Secretary of the Committee, 29 West 39th street, New York, N. Y.

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the council of The American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published.

Below are given records of the interpretations of this committee in Cases Nos. 789, 797, 798, 799, 800 and 801, they having been approved by the council. In accordance with established practice, names of inquirers have been omitted.

Case No. 789
(Interpretation of Par. P-325)

Inquiry: Is it permissible, under the provisions of Par. P-325 of the Code, to attach supporting lugs for boilers by welding instead of riveting?

Reply: It is the opinion of the Committee that provisions should be made for attachment of the supporting lugs, hangers, or brackets of boilers by fusion welding and that the intent of the Code will be met provided (a) the lugs, hangers, or brackets are made of steel plate sanctioned by the Code for use in the shells of boilers; (b) they are of the same size as required for riveting; (c) they are attached by fillet welds along the entire periphery or contact edges of the size and form shown in sketches 1 to 4, inclusive, in Fig. P-7, in which t'' is the shell thickness; (d) the welding meets the requirements of Pars. P-101 to P-111, inclusive, omitting the radiographic examination; (e) the supporting lugs, hangers, or brackets are attached prior to stress relieving; and (f) the stresses, computed by dividing the total load on the lug, hanger, or bracket by the minimum cross-sectional area of the weld, do not exceed, for tension and compression 40 percent, and for shear 32 percent of the stress values given in Table P-8 multiplied by the welded-joint efficiency.

Case No. 797.—(Annulled)

Case No. 798.—(In the hands of the Committee)

Case No. 799
(Interpretation of Pars. P-15 and P-16)

Inquiry: Case No. 769 permits the use of chrome-manganese-silicon boiler plate (Specifications S-28) for riveted-drum construction. Par. P-15 limits the crushing strength of steel plates to 95,000 pounds per square inch, and Par. P-16 gives the ultimate strength in single shear for steel rivets as 44,000 pounds per square inch, and 88,000 pounds per square inch in double shear. May these values be increased for the chrome-manganese-silicon steel plate (Specifications S-28), and what corresponding values should be used in designing riveted drums built from such material?

Reply: The crushing strength for plate in accordance with Specifications S-28 for the Grade A material, which is the only one that will be used for rivets, should be limited to 120,000 pounds per square inch. The ultimate strength for rivets in single shear is 60,000 pounds per square inch, and in double shear 120,000 pounds per square inch.

Case No. 800
(Interpretation of Par. UA-22d)

Inquiry: Par. UA-22*d*(1) requires a flange hub height which is excessive for shells or pipes having heavy walls. Would not some shorter height of hub be sufficient in the case of flanges attached to shells or pipes 1 inch or greater in thickness?

Reply: It is the opinion of the Committee that the intent of this rule will be met if a minimum distance of 3 inches, measured from the back of the flange, is used for the height of the hub with vessels or pipes 1 inch or greater in thickness. The straight section of the hub as required in Par. UA-22*d*(2) should be at least 1½ inches in such cases.

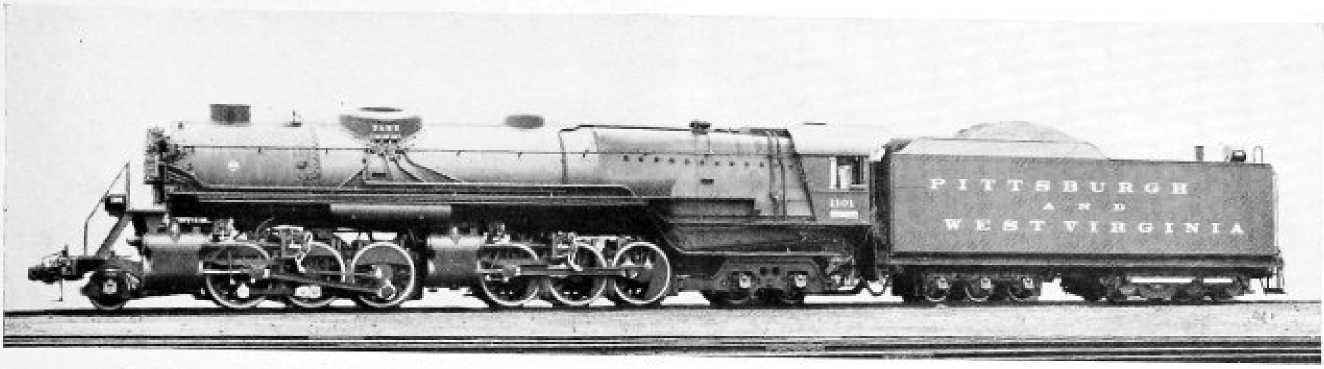
Case No. 801
(Interpretation of Par. P-102c)

Inquiry: If the joint tension test specimen under Par. P-102*c* fails outside the weld within the base metal and the tensile strength is less than the minimum of the specified tensile range of the plate used, does this constitute a cause for rejection of the plate?

Reply: The acceptance of the plate is based on the tests required in the plate specifications. It is recognized that stress relieving may reduce the tensile strength of the plate as received from the mill but this reduction in tensile strength is considered to be covered by the factor of safety of 5. The tension test on the joint specimen specified in Par. P-102*c* is intended as a test of the welded joint and not of the plate.

Metal Tank Industry Submits 1935 Code Budget

The Code Authority for the metal tank industry has made application to the National Industrial Recovery Board for approval of a $17,925 budget to cover code administration expenses from January 1 to June 16, 1935. The suggested basis of contribution is ⅜ of 1 percent of the dollar volume of sales, payable monthly, and based on sales made during the preceding month.



Single-expansion articulated locomotive built for the Pittsburgh & West Virginia by the Baldwin Locomotive Works

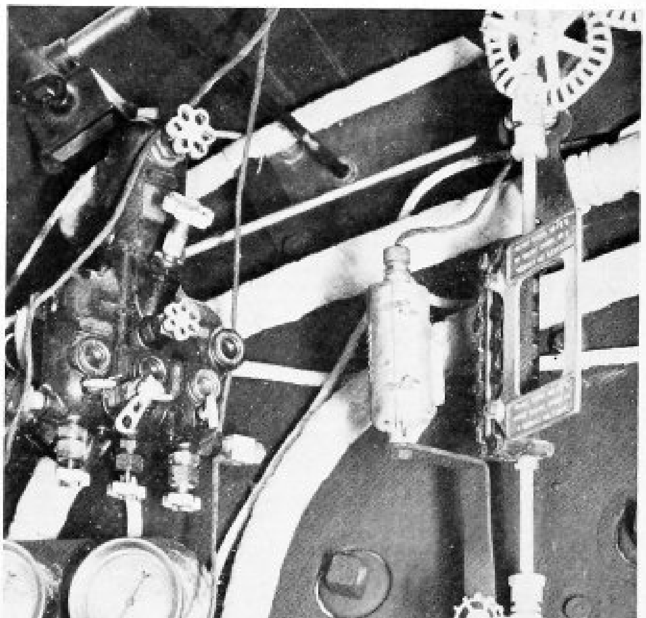
Articulated Locomotives for Pittsburgh & West Virginia

The Pittsburgh & West Virginia is a short road—138 miles long—connecting the rich coal fields of western Pennsylvania with the Pittsburgh district and thence across the upper end of West Virginia into Ohio. Its traffic is heavy and consists largely of soft coal. Heretofore this traffic has been handled by 22 Consolidation and three Mikado locomotives. Of the 2-8-0 type locomotives which were built between 1907 and 1921 nineteen have 58-inch drivers and a rated tractive force ranging from 54,000 pounds to 58,600 pounds. The three 2-8-2 type locomotives which were built in 1918 have a rated tractive force of 54,725 pounds.

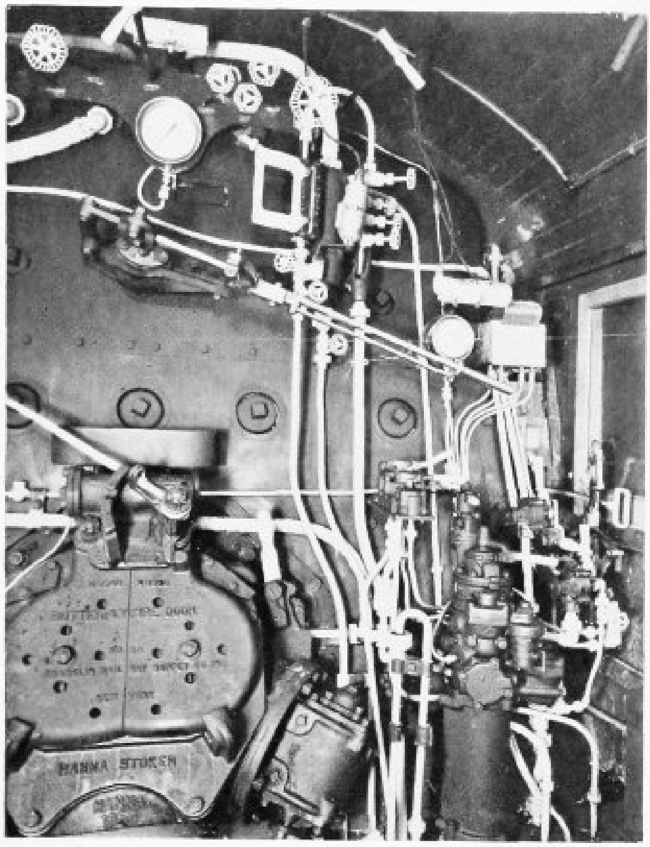
Three new single-expansion articulated locomotives built by the Baldwin Locomotive Works have recently been placed in service. These locomotives have a rated tractive force of 97,500 pounds for the locomotive itself. This may be supplemented by a Bethlehem auxiliary locomotive developing 16,000 pounds additional tractive force which is applied to the rear six-wheel tender truck. One of the new locomotives is thus capable of performing the work formerly requiring the use of two of the older locomotives. They will be employed mainly for hauling coal trains on the 35½-mile run from Connellsville, Pa., to Rook, Pa., a suburb of Pittsburgh. In the preparation of the design the builders were restricted to an axle load of 65,000 pounds, a track curvature of 18 degrees, and to certain specified clearances. The stack height is 16 feet 2 inches; the cab width, 10 feet 6 inches, and the width over running boards, 11 feet 4 inches.

The boiler is of the straight-top, wagon-bottom type with a Belpaire firebox, the outside diameter of the first one of the three shell courses being 94 inches. The firebox has a length of 144⅛ inches and a width of 102¼ inches, which provides a grate area of 102.3 square feet. The combustion chamber is 74 inches long and the Security brick arch is carried on five seamless steel arch tubes. The length over tube sheets is 23 feet and the total length of the boiler and smokebox, 53 feet 8⅜ inches. The evaporative heating surface is 5914 square feet. The superheater is Type A with 1873 square feet surface. Coal is fed to the grate by a Hanna stoker. Shell and firebox sheets are of O.H. basic steel, the former being supplied by the United States Steel Corporation and the latter by the Otis Steel Company. All tubes and flues are of National seamless steel. The boiler pressure carried is 225 pounds per square inch. No feed-water heater was applied. The boiler is fed by two Chicago Type T injectors furnished by the Ohio Injector Company through Hancock check valves mounted on the right and left sides of the first shell course.

Observations of the cab photographs shows an interesting and simple device provided to show the change in



Left-hand water column with frame showing change in water level on 1½ per cent grades



General view of right-hand side of the back boiler head in the cab of the P. & W. Va. locomotive

the indicated water level due to grade. This consists of a rectangular frame attached to the water columns on the right and left-hand sides. The width of the opening is equal to the change in water level due to a change from an up-hill to a down-hill grade of 1½ percent. The wording cast on the top of the frame reads: "Water level on 1½ percent up-grade equal to two gages on level" and on the bottom of the frame "Water level on 1½ percent down grade equal to two gages on level."

Other boiler mountings and trimmings included are Franklin Butterfly No. 8A automatic fire door, T-Z boiler plugs, two Wilson close-clearance blow-off valves, Consolidated safety valves, Crosby steam gages, Renewo blower valves, Barco blower fittings, King sanders, Viloco bell ringer, Sunbeam No. 3 turbo headlight generator, and Sunbeam 18-inch headlight mounted on a bracket attached to the upper deck in front of the smokebox.

A new and particularly interesting design has been worked out by the Baldwin Locomotive Works for the waist bearer between the front engine frame and the boiler. This waist bearer is unique in that the middle portion of the central steam pipe is incorporated as a part of the casting itself. The upper portion of the waist bearer was designed to meet unusual conditions of limited vertical space between the driving wheels and the boiler.

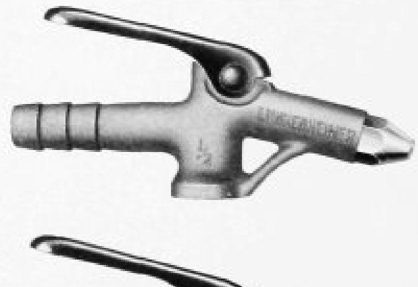
The rectangular type tender, which has a capacity for 20,000 gallons of water and 20 tons of coal, weighs 377,600 pounds loaded and is mounted on an open-bottom cast-steel tender frame furnished by the General Steel Castings Corporation.

Principal Boiler Details of the Pittsburgh & West Virginia 2-6-6-4 Type Locomotives

Type of locomotive	2-6-6-4
Road numbers	1100-1102
Service	Freight
Boiler:	
Type	Belpaire, straight-top, wagon bottom
Steam pressure	225 lb.
Fuel	Soft coal.
Diameter, first ring, outside	94 in.
Firebox, length and width	144⅛ in. by 102¼ in.
Height mud ring to crown sheet, back	75½ in.
Height mud ring to crown sheet, front	95½ in.
Arch tubes, number	5
Combustion chamber length	74 in.
Tubes, number and diameter	241—2¼ in.
Flues, number and diameter	66—5½ in.
Length over tube sheets	23 ft.
Grate area	102.3 sq. ft.
Heating surfaces:	
Firebox and comb. chamber	450 sq. ft.
Arch tubes	49 sq. ft.
Total firebox	499 sq. ft.
Tubes and flues	5,414 sq. ft.
Total evaporative	5,913 sq. ft.
Superheating (Type A)	1,873 sq. ft.
Comb. evaporative and superheating	7,786 sq. ft.
Feedwater heater	
Tender:	
Style	Rectangular
Water capacity	2,000 gal.
Fuel capacity	20 tons.
Trucks	Six-wheel
General data estimated:	
Rated tractive force, 81½ per cent	97,500 lb.
Rated tractive force, aux. locomotive	16,000 lb.
Speed at 1000 ft. piston speed	35.16 m.p.h.
Piston speed at 10 m.p.h.	284.5 ft.
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	75.2
Weight on drivers ÷ tractive force	4.08
Weight engine ÷ comb. heat. surface	68.0
Boiler proportions:	
Tractive force ÷ comb. heat. surface	12.78
Tractive force × dia. drivers ÷ comb. heat. surface	799
Comb. heat. surface ÷ grate area	76.2
Firebox heat. surface ÷ grate area	4.87
Firebox heat. surface, per cent of evap. heat. surface	8.45
Superheat. surface, per cent of comb. heat. surface	24.1

Renewable-Disk Air Nozzles

Two new designs of bronze air nozzles with renewable non-metallic disks have been placed on the market by the Lunkenheimer Company, Cincinnati. One is made with an integral hose end and the other with a female



The new Lunkenheimer air nozzles are made with either pipe or hose connections

pipe end. Either pattern can be furnished with pointed, flat or extension tip. These air nozzles are suitable for blowing dust, dirt, chips, filings, borings and other matter, being more effective and safer to use than brushes, rags or hand bellows.

The valve disk is especially compounded for air service and can be renewed easily by simply unscrewing the nut at the bottom of the nozzle, removing the spring and old disk and then inserting a new disk. Provision is made for hanging the air nozzle on a nail or small hook when not in use.

Spark and Heat Shields

It is not unusual, when heavy cutting work is encountered, to find the cutting operator using some sort of a makeshift spark and heat shield. These are often placed just behind the cutting blowpipe head to ward off the shower of sparks that often occurs on starting a heavy cut, punching a hole, or working on a casting or dirty material. Often a piece of asbestos paper is placed over the blowpipe tubes just behind the blowpipe head. While this may offer some relief it is at best a makeshift.

Some thought has been given to the design of a spark and heat shield than can be attached easily and quickly to the blowpipe, will work efficiently, and can be made a permanent part of the cutting outfit. This has resulted in the development of two designs, differing only in the method for attaching the shield to the blowpipe. Inasmuch as one may be fabricated more easily, with the shop facilities at hand than the other, depending on what equipment the shop may have, both designs are described. The cost is slight.

Fig. 1 shows a design that makes use of a circular plate of brass divided in two parts, a split shield, that attaches to the blowpipe by closing around the blowpipe tubes. A spring is used to make a tight fit and keep the shield snug.

Fig. 2 shows another design also using the circular plate of brass, but in which the shield is firmly attached to the blowpipe by making a squeeze fit with a sliding plate clamp.

Spring Clip Shield

The materials necessary for the construction of the spring clip shield shown in Fig. 1 are as follows:

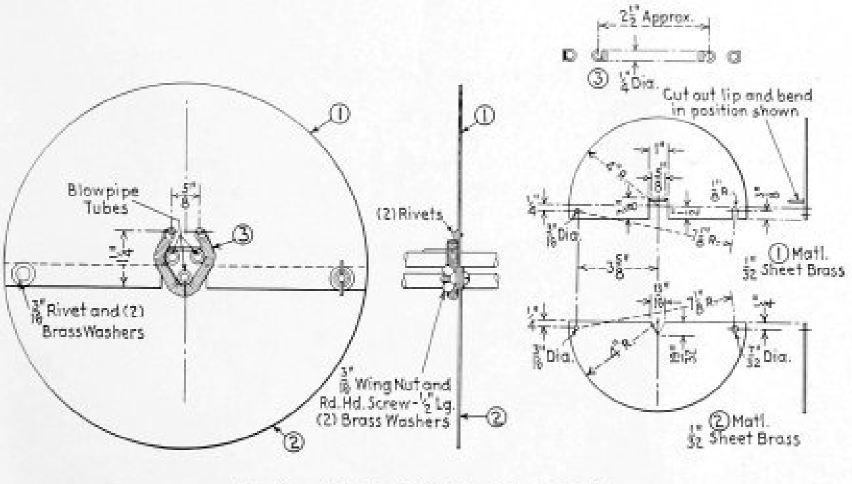


Fig. 1.—Details of shield with spring clip

- 2—sheet brass plates, $\frac{1}{32}$-inch thick, one 4-inches by 8-inches, the other $4\frac{1}{2}$-inches by 8-inches.
- 1—steel spring about $2\frac{1}{2}$-inches long, of about $\frac{1}{4}$-inch diameter.
- 1—$\frac{3}{16}$-inch wing nut, brass.
- 1—$\frac{3}{16}$-inch diameter round head screw, brass, $\frac{1}{2}$-inch long.
- 4—brass washers to fit $\frac{3}{16}$-inch screw.
- 1—$\frac{3}{16}$-inch rivet, brass.
- 2—$\frac{1}{8}$-inch rivets, brass.

It is a simple enough job to make the shield itself. Simply prepare the brass plates as shown in Fig. 1, attach the necessary rivets which make it possible to swing open and to close the shield around the blowpipe tubes, and attach the steadying spring. Then put the wing nut, washers, and bolt in place and the shield is ready for use.

Obviously the notches and spaces made to fit the blowpipe tubes can be altered and changed to fit blowpipes having other arrangements of tubes.

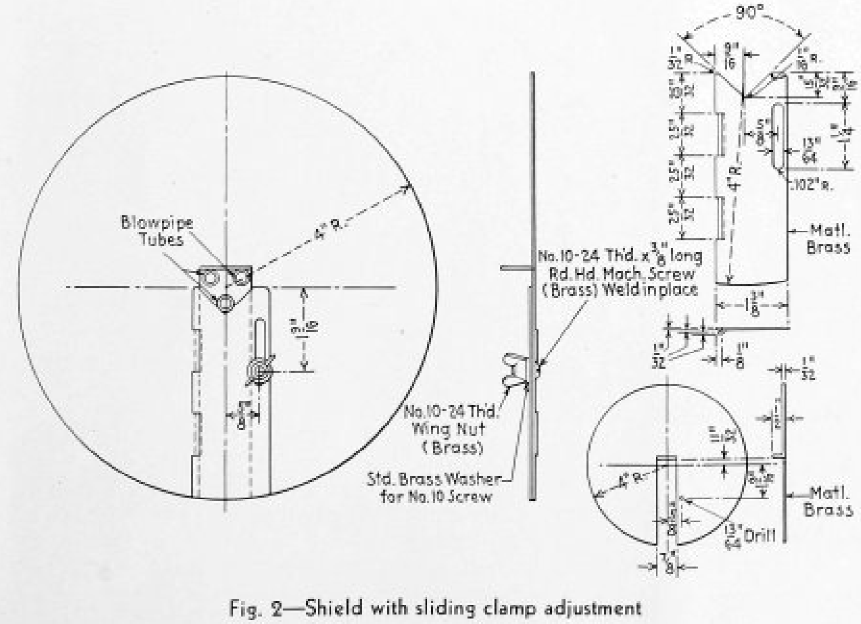


Fig. 2—Shield with sliding clamp adjustment

Sliding Clamp Shield

The materials necessary for construction of the sliding clamp shield shown in Fig. 2 are as follows:

- 1—sheet brass plate, $\frac{1}{32}$-inch thick, 8-inches square.
- 1—sheet brass plate, $\frac{1}{32}$-inch thick, $1\frac{3}{8}$-inches wide and 4-inches long.
- 1—No. 10-24 thread wing nut, brass.
- 1—Standard brass washer for No. 10 screw.
- 1—No. 10-24 thread, brass, $\frac{3}{8}$-inch long, round head machine screw.

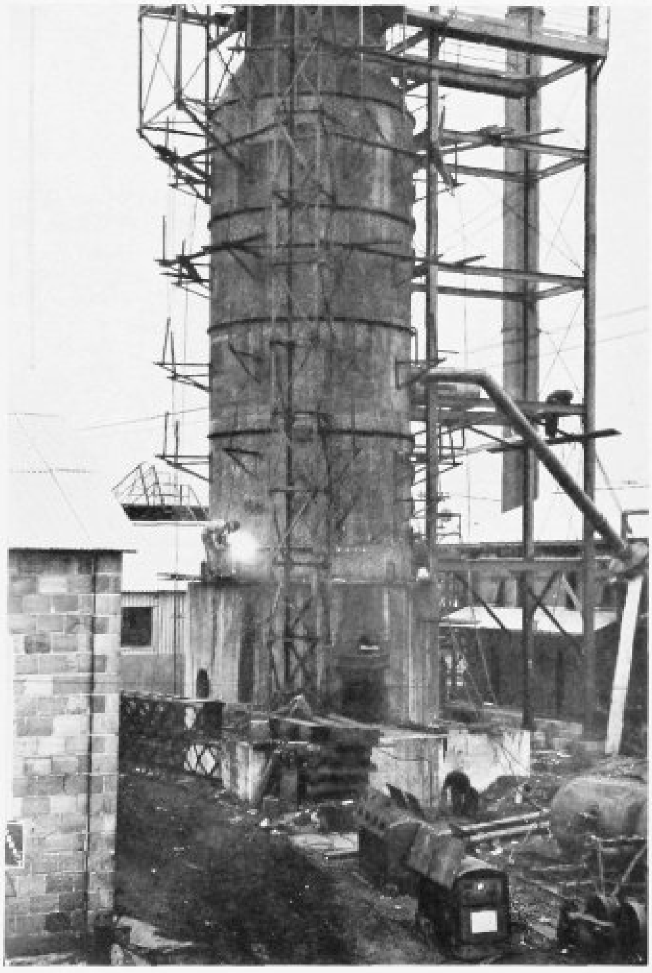
Fig. 2 is a working drawing of this shield. Construction is a simple matter of cutting the brass plates to the dimensions shown, bending the necessary lips on the sliding clamp part, and at the top of the slot in the shield, and securely bronze-welding the brass bolt into place.

For inserting the blowpipe, the wing nut is loosened, the clamp dropped down and swung away completely from the shield slot. The shield is then placed over the blowpipe tubes, the clamp swung into place, being sure the lips on the left edge are fitted over the edge of the shield groove, the clamp pushed up tight and the wing nut tightened.—*Oxy-Acetylene Tips.*

Arc Welded Bubble Tower

A bubble tower which grows 2¾ inches taller in service and which is the first of its type to be built under the new vacuum code is under construction at Maurer, N. J., for the Barber Asphalt Company. This equipment is part of a vacuum distillation unit designed and installed by The Lummus Company for production of asphalt. The tower is being erected by the Chicago Bridge and Iron Works. It is of arc welded construction throughout.

The tower is 55 feet high, 15 feet diameter and will operate at 650 degrees F. under vacuum. At this high temperature the structure is 2¾ inches taller than when cold. It is being entirely fabricated in the field with the exception of the bonnet.



This bubble grows 2¾ inches taller in service

The shell is built of steel plates ranging from ⅞ inch thick at the bottom to ¾ inch thick at the top. All joints in the shell are butt joints. In the horizontal joints the plates are vee'd to 45 degrees with ⅛ inch point. In the vertical joints the plates are vee'd to 60 degrees. All joints in the shell are welded with 5/32-inch electrode.

The decks, or bubble trays, inside the shell are built of ½-inch plate. Each tray contains 36 risers and is supported on angles welded to the inside of the shell. The trays and supporting angles are welded with 7/32-inch electrodes.

Arc welding is used to particular advantage in the construction of this bubble tower. In addition to high ductility, the shielded arc weld metal shows a tensile strength of 65,000 to 75,000 pounds per square inch. Resistance to corrosion, so important in a structure of this type, is assured by the welded joints since the shield arc provides weld metal of greater corrosion resistance than cold rolled steel. Welding equipment used in building this tower was supplied by The Lincoln Electric Company, Cleveland.

Ventilated Goggle for Hot Workers

For men who work in confined spaces or where the temperature or humidity is high a goggle of a new design, known as Duralite-50 Hot Workers' Goggle, has been developed by the American Optical Company, Southbridge, Mass.

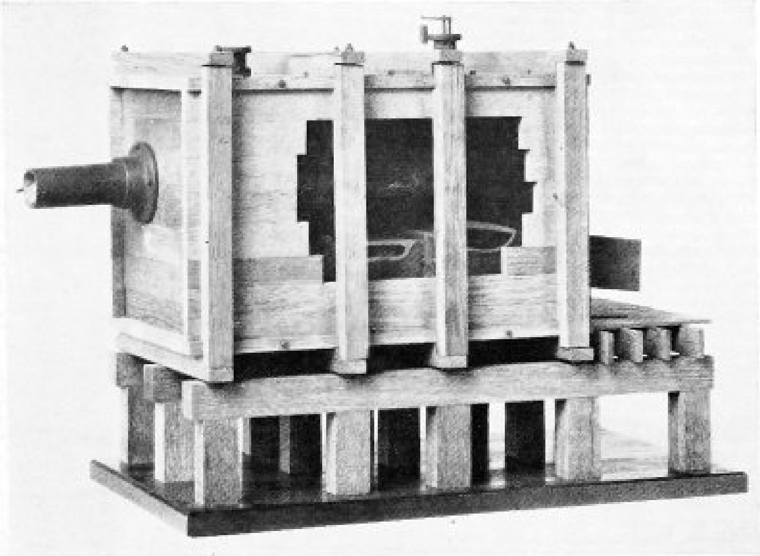
Goggles with generous ventilation

This new goggle practically doubles the area usually allowed for ventilation. The extra ventilation in back of the lenses keeps them free from fogging and steaming and also keeps the area around the eyes cool and so prevents perspiration from obscuring the vision. As a consequence the hazards of stumbling, falling or colliding with objects because of obscured vision due to fogged lenses are eliminated. Besides permitting clear and comfortable vision Duralite-50 Hot Workers' Goggles provide dependable eye protection. They are of sturdy construction and are fitted with super-armorplate lenses.

Condition of Equipment: The Class 1 railroads on February 1 had 10,419 locomotives in need of classified repairs, compared to 10,344 on January 1, an increase of 75. Locomotives stored serviceable totaled 3990 compared to 4778 on January 1, a decrease of 788.

Wooden Steam Boilers*

***By Frank A. Taylor*†**



The original of this wooden steam boiler was used at the Center Square Station, Philadelphia Water Works, 1801

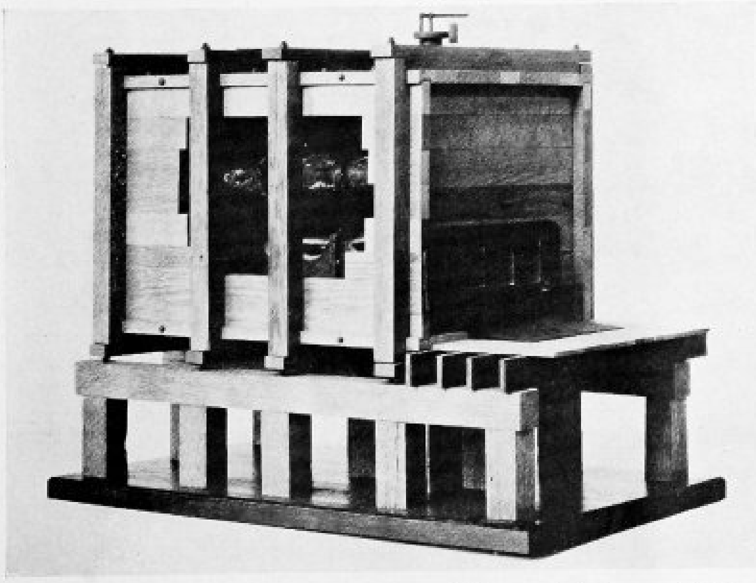
That boilers for the generation of steam might be made of wood is a strange suggestion. That they were at one time so made is illustrated by a model recently prepared for exhibition in the engineering collection of the United States National Museum at Washington. The model depicts a wooden boiler built for the Center Square Pumping Station of the Philadelphia Water Works in 1801. The boiler was essentially an internally fired boiler, the outer skin or shell of which was a rectangular wooden chest enclosing a wrought-iron fire-box and flue. The illustrations give a good idea of the external appearance.

The chest was nine feet square inside at the ends and was made of white pine planks five inches thick, braced upon the top and bottom with oak scantling ten inches square, the whole being securely bolted together by one and one-quarter inch rods passing through the planks. Inside of this chest was an iron firebox twelve feet long, six feet wide and one foot ten inches high, the front of which extended through the front of the boiler with a wide flanged shoulder which was securely bolted to the planks to make a watertight connection. On this flanged part were hung the firedoors. The portion of the firebox back of the doors was the combustion chamber, made slightly higher than the rest, with the top curved slightly upward to form the semblance of a combustion arch. This section was fitted with grates and connected to a vertical ashpit section which extended downward through the bottom of the wooden chest through a watertight fitting.

Back of the combustion chamber the firebox was a wide flat rectangular box, stayed and stiffened by vertical tubular pipes of eight to twelve inches inside diameter which opened through the top and bottom sheets of the firebox. These were in effect water tubes, an example which seems to have been overlooked by the historians of the watertube boiler. At the back of the firebox, at the top, was connected one end of a flat oval-sectioned flue which extended to the front of the boiler and then back in a large U-bend to the stack at the back of the boiler. In operation, water in the boiler completely surrounded the firebox, ashpit, and flue, and circulated through the pipes that were located in the firebox.

At the time a great gain in economy of operation was supposed to be effected by the non-conducting properties of the wooden shell, and tests did prove that there was a saving. This was found to be only temporary, however, as great difficulty was experienced in keeping the chest water and steam tight. This boiler, as were all that were tried, was replaced within a few years by a boiler of cast iron. The pressure of the steam that was generated in the boiler was only two and one-half pounds per square inch, which is a far cry from the present-day requirements of a modern steam pumping station.

The idea for wooden steam boilers was borrowed by the early engineers directly from the distillers of whiskey. At the time the distillers were having considerable difficulty because of the injurious effect of the mash on the wood, but the steam pioneers considered that it remained to be tried whether "simple steam and water" would have a like effect. After 1801 there was further experimentation with wooden boilers made in conical and other shapes and constructed with hoops and staves as tanks and casks were made. None of these lasted long enough to warrant the continuation of the practice.



Model of wooden steam boiler at the National Museum, Washington, D. C.

* From information appearing in *Mechanical Engineering* for March.

† Smithsonian Institution, Washington, D. C.

MARINE BOILERS II*

By Captain C. A. Jones, U. S. N.† and Lieutenant Commander T. A. Solberg, U. S. N.‡

Of the general requirements, those of minimum space and weight have the greatest effect on naval boiler design. There are many more restrictions today than ever before, not only because of ship tonnage limitations, but also because present ship design makes it imperative that every pound of weight and every foot of space shall contribute in a maximum degree, not only to the required speed and operating radii, but also to the maximum offensive and defensive characteristics. Space and weight factors, therefore, generally are responsible for the omission of economizers and air preheaters from naval boilers. Reheaters, obviously, are out of the question.

The maximum steam pressure and temperature practicable is limited by these two considerations, as well as by reliability, maneuvering characteristics, and other general operating conditions. Vulnerability also must be given thought, for all machinery must be disposed in such a way and in such spaces that maximum protection is afforded to every unit of the intricate installation. It must be remembered that disabling or disruption of the service of any one of these may mean disaster in battle. This, also, largely has prevented the use of automatic apparatus, even though it has been developed to a high state of perfection for shore plants.

Large increases in efficiency have been denied in a measure to the naval designer because of the difficulties surrounding the application of high steam pressures and temperatures to naval power plants. It is well known that pressure increases yield greater relative economy of the machinery plant than increases in temperature alone. Pressure increases also must be accompanied by certain minimum superheats to prevent undesirable moisture contents in the lower turbine stages. The use of superheat involves either a provision for temperature control or a superheater arrangement which will not be damaged when maneuvering or by sudden changes in conditions.

The use of waste-heat recovery apparatus in naval units must be studied not only on the basis of fuel saving, first cost, weight, space, long life, and maintenance, but also in regard to the possibility of introducing operating difficulties and decreasing the reliability of operation.

The above indicates some of the more important details and difficulties which confront the naval designer. They are given constant study in order to take advantage of every new development. As a result of this, in spite of the difficulties involved, there is a trend, if not a definite policy, toward higher pressures and higher temperatures for new naval construction.

Design Features of Naval Boilers

(*a*) *Weight, Space, Capacity and Rating.* Considerable advance has been made so that higher capacities than ever before are now being obtained with units having less weight and occupying less space. This is best shown by the destroyer boilers listed as Unit *F* in Table 1 and a boiler now building listed as Unit *G*. The latter is fitted with superheater and economizer. The use of welded drums, better distribution of heating surfaces, improvement in boiler fittings, accessories, furnaces, and refractories are responsible for the advances which have been made. Except in special vessels, such as the airplane carriers *Saratoga* and *Lexington*, eight boilers is the largest number of units employed. Based on present design, it is probable that even these vessels would now be fitted with no more than 12 instead of 16 boilers.

There is a positive trend at the present time to operate naval boilers at higher ratings. Recent tests have led to increasing the maximum operating rate from one pound of oil per hour per square foot of heating surface to 1.1 pounds. This specification also requires that the boiler must perform satisfactorily at 20 percent overload, or a maximum rate of 1.32 pounds. These ratings are obtained in all tests of boilers at the Naval Boiler Laboratory. The latter limit produces a heat release of 260,000 B.t.u. per cubic foot of furnace volume or more.

The combined effects of operating at higher ratings and utilizing larger sizes of boilers result in considerable weight savings, as a smaller number of boilers per ship reduces the total refractories, furnace structures, boiler casings and supports, piping, and miscellaneous fittings required. It is undesirable, however, to reduce the number of boiler units below certain limits due to the loss of too large a percentage of power in case of casualty to one unit and also uneconomical operation at cruising speeds. Vulnerability, space requirements and arrangements of boilers with respect to other machinery are affected also, but in some cases adversely.

These advantages are being realized also in the merchant marine, where steam releases have been increased in some cases from the usual 3 to 6-pound range to as high as 10 or 12. At the same time boilers having 10,000 square feet of heating surface are making their appearance.

For modern naval units the maximum heating surface approximates 11,720 square feet with maximum operating rates giving steam releases of 16 pounds per square foot.

Until recently it has been the common practice to rate marine boilers on the basis of oil burned per square foot of generating surface. With the advent of high superheat, economizers, and air preheaters this method of rating became obsolete. The Navy now, in connection with their ship design and in order to prevent a departure from a reasonable design, places, among other detail limitations, a limitation on the B.t.u. absorbation per hour per square foot of radiant heat absorbing surface, on the B.t.u. absorbation per hour per square foot

* Second instalment of a paper read before The Society of Naval Architects and Marine Engineers, New York, November 16, 1934.

† Head of Design and Construction Division, Bureau of Engineering, Navy Department, Washington, D. C.

‡ Officer-in-Charge, Naval Boiler Laboratory, Navy Yard, Philadelphia, Pa.

of the total heating surface and on the B.t.u. absorbation per hour per cubic foot of furnace volume.

(*b*) *Operating Pressures and Temperatures.* The Navy probably led all commercial practice in the matter of working steam pressures for a short period subsequent to its wholesale adoption of the watertube boiler. The reverse situation soon was created, and it is extremely doubtful that naval practice can ever utilize or even approach the pressures and temperatures now used in shore plants. At the present time boilers designed for 450 pounds working steam pressures and total temperatures of 650 degrees F., with a possibility of conversion to 850 degrees, are being built. It is believed that for naval purposes maximum temperatures probably will not exceed 750, and the upper steam pressure limit probably will be 600 pounds. Pressures in excess of this figure increase the gross power plant weight, cause weight concentrations in localized areas which in return require additional supports, impose increased repair difficulties, and also produce operating problems and complications.

The merchant marine has shown a marked inclination toward taking advantage of the more efficient steam cycles. The average boiler pressures of 225 pounds are being increased for new construction to 400 and 450 pounds. Temperatures likewise have been stepped up, and 600 degrees F. is no longer unusual and temperatures of 850 degrees F. have been proven practicable for this service because these vessels operated at more fixed and constant conditions and have few of the operating complications of naval vessels.

(*c*) *Economizers.* The naval service, up to the designs of the past year, has avoided studiously the use of waste-heat recovery apparatus. The principal objections have been those of weight and space required and the tendency to resist adding to the power plant any equipment which might reduce its reliability or, in other words, increase the possibility of operating and upkeep troubles. In the case of economizers there has been the added fear of the usual corrosion troubles to which they are so susceptible.

The decision to use 450-pound boilers caused further study of the possibility of using economizers and air preheaters in order to remove the higher heat content of the gases leaving the last generating surfaces. As a result, one small group of *A*-type destroyer boilers has been designed with an economizer unit in each of the two uptake ducts carrying the gases from the tube banks. The ducts discharge into a single breeching. The economizer units are of unique construction, using aluminum gill rings of the Foster Wheeler construction. This enables considerable weight saving and gives high efficiency. It is of interest to note that gill rings made of aluminum were developed at the request of the Navy. The development of a satisfactory method of securing these to the elements was of considerable difficulty.

The ingenious manner in which economizers have been incorporated in these boilers demonstrates the feasibility of their use in practically all vessels, as space and weight handicaps on a destroyer are certainly a maximum. It is believed that their use on merchant vessels using 400 pounds steam pressure and above is highly desirable, except where air preheaters are more attractive. New apparatus and better arrangements for air removal have been incorporated in later designs so that corrosion troubles from this source should be reduced to a minimum. If more expensive construction is resorted to, corrosion resisting materials are available to insure maximum reliability and freedom from operating troubles.

(*d*) *Air Preheaters.* These auxiliaries are practically unknown in naval ships. Some thought has been given to their use, as indicated by their inclusion in the two smaller of four boilers being installed in some destroyers. It is quite probable that the use of air heaters will become more desirable—and perhaps even imperative—with the rapidly increasing use of heavily cracked fuel oil. The rate of combustion of these oils is comparatively slow, and provision of heated air naturally increases the speed of burning. This will tend to prevent the losses from unburned carbon and hydrocarbons, which many tests have shown to be considerably higher than with straight run oils. The introduction of cracked oils as fuel is rather recent, and consequently the present knowledge of their proper burning is limited. It is almost certain that future work will determine that high air temperatures are a prerequisite, not only to proper burning, but to prevent the bothersome fly-ash or sinosphere discharges from the smoke pipe. Analyses of these usually show high carbon content.

The design of air heaters for marine usage must be considered carefully so that space and weight will be kept at their minima and also so that the pressure drops on each side will be as low as possible. The use of corrosion-resisting materials would be conducive to weight saving because extremely thin plates could be utilized. The forced-draft blower should be arranged so that it handles the air before the heater.

It should be remembered that economizers in a sense parallel or conflict with the advantages which can be gained by stage feed heating using bled steam from the turbines. The latter system of feed heating, however, has its limitations for naval vessels, because of wide variations of operating speeds. A highly efficient merchant vessel design, on the other hand, could utilize the advantages of both stage heating and air heating.

(*e*) *Superheaters.* It can be stated that the use of superheated steam is specified for all new construction. It is worthy of note, also, that a large number of new merchant vessels are designed with superheaters. For many years there has been a tendency to resist the use of superheat, especially for naval boilers, because of the operating and maintenance difficulties which might be introduced. Development work in superheater design and shore plant experience have overcome some of these prejudices. Superheat, also, is a necessity, if higher pressures are to be employed.

A superheater having a nearly flat temperature characteristic is mandatory because of the variety of operating conditions encountered in naval vessels. Many of these, such as sudden stops and rapid speed changes, impose severe operating conditions.

Except in the case of some special-type vessels to be fitted with separately fired superheater units, interdeck superheaters are used in modern naval boilers. The flat temperature characteristic is specified. This is obtainable only by locating the unit in that region of the tube banks where the percentage of heat absorption to the total heat absorption of the boiler is a constant or nearly so over the whole operating range.

The percentage of heat absorbed by the fireside rows decreases with increasing power, while that of the rear tubes increases. The constant ratio area is somewhere between, depending, of course, on other design features. These can be varied also to obtain the desired results. For instance, in some boilers the best location for a superheater might be behind the third or *C* row, while in others the desirable area might be behind the fifth or *E* row. In the latter case, a wider tube spacing and the use of larger diameter tubes in the fireside rows would be found to give approximately the same results as a closer spacing of smaller tubes in the former case. Generally speaking, the location will be such that part of the superheater receives a small amount of radiant heat, while the temperature of the gases entering the superheater will be in the order of 1600 degrees F. The superheater of a boiler now on test at the Naval Boiler Laboratory has a very satisfactory characteristic, the temperature range being from 574 to 677 for combustion rates from one-quarter pound to 1.1 pounds per square foot of boiler water heating surface.

Special attention must be given to the steam distribution in the various tubes. At low powers poor distribution may result in tube distortion and shortened tube life from both internal and external oxidation.

Controlled operation is desirable when operating at varying capacities, but this, of course, is not possible with existing designs of integral superheaters, except in so far as the outlet temperature can be controlled by desuperheating devices or where the superheater is installed in one leg of a three-drum boiler and the division of gases between the two legs is controlled by dampers. This, however, provides no protection to the superheater itself. Devices for accomplishing this are now coming on the market but may be considered in the experimental stage until thoroughly proven over a period of time under actual service conditions.

(To be continued)

Revisions and Addenda to the A. S. M. E. Boiler Code

It is the policy of the Boiler Code Committee of the American Society of Mechanical Engineers to receive and consider as promptly as possible any desired revision of the Rules and its Codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later in the proper place in the Code.

The following proposed revisions have been approved for publication as proposed addenda to the Code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the Code, and are submitted for criticism and approval from any one interested therein. It is to be noted that a proposed revision of the Code should not be considered final until formally adopted by the Council of the Society and issued in pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets []. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

Revisions

PAR. P-12. Add the following as (*c*):

c Malleable iron as designated in Specifications S-15 may be used for boiler and superheater connections under pressure, such as pipes, fittings, valves, and their bonnets for pressures not to exceed 350 lb per sq in., provided the steam temperature does not exceed 450 F.

PARS. P-332 AND U-65. Add the following as fourth section of P-332 and as (*c*) of U-65:

Those parts of a boiler (pressure vessel) requiring Code inspection and which are furnished by other than the shop of the manufacturer responsible for the completed vessel shall be fabricated by a manufacturer in possession of a Code symbol stamp and shall be inspected by a qualified inspector. The data sheets, in triplicate, covering the part or parts shall be executed by the manufacturer and the inspector in accordance with the Code requirements, and forwarded, in duplicate, to the manufacturer of the finished vessel. This partial data report, together with his own inspection, shall be the final inspector's authority to witness the application of a Code stamp to the vessel. The manufacturer who completes the vessel and the shop inspector making the final inspection shall be responsible for its meeting Code requirements. (A sample manufacturers' partial data report form appears below.)

MANUFACTURERS' PARTIAL DATA REPORT

A Part of Boiler or Vessel Fabricated by One Manufacturer for Another Manufacturer

1. Manufactured by ....
   (Name and Address of Manufacturer of Part)
2. Manufactured for ....
   (Name and Address of Manufacturer of Boiler or Vessel)
3. Identification—Manufacturer's Serial No. of Part....................
   Constructed According to B. P. No.........B. P. Prepared by......
4. Description of Part Inspected..
5. Shell...Length...Diameter...Thickness...Material Maker's Brand..
6. Heads—Form ....Thickness...Material Maker's Brand..
   (Flat, Ellipsoidal, or Dished and Radius)
7. Openings—Reinforced ....Unreinforced...................
   (Number and Size) (Number and Size, Including Tube Holes)
8. Seams—Riveted, Forge Welded, Fusion Welded, Brazed, or Seamless..
9. Riveted Longitudinal Seam...Pitch of Rivets..Diam. of Hole..Eff...
   (Lap or Butt, Single, Double, Triple, or Quadruple)
10. Riveted Girth Seams....Pitch of Rivets....Diam. of Hole....Eff....
    (Lap or Butt, Single or Double)
11. Results of Physical Tests of Welded Seams, Power Boiler Drums and Vessels Built Under Pars. P-101 to P-111, Inclusive, or Par. U-68.
    Joint Specimens. T. S.................Lb per Sq In.
    All Weld Metal Specimens. T. S.......................Lb. per Sq In.
    (If Thickness of ⅝ In. or More)
    Elong. Per Cent...Free Bend Test. Ductility Per Cent..Sp Gr....
12. X-Ray Technique. Is a definite record of X-Ray Technique for this vessel on file with the manufacturer?..............................
    Were the X-Ray films examined and found to be in accordance with Code requirements?..............................
13. Vessels Built Under Pars. U-69 and U-70. Give date of last qualification test of each welder of parts covered by this report........
    Were qualification tests found acceptable for this class of vessel?
14. Max. S. W. Pressure......Hyd. Test......Max. Oper. Temp.......
    Joint Unit Working Stress.....................F. S.................
15. We certify the above data to be correct and that all details of material, construction, and workmanship of the object conform to A.S.M.E. Code requirements for.......................................
    ....
    (Power Boiler Drum or Unfired Pressure Vessel Built Under Pars. P-101 to P-111, or U-68, U-69, or U-70)
    Date.......................19....

Signed ....
(Manufacturer)

....
(Representative)

......................Inspector

Commission No. ....
(State or Natl. Board)

PARS. P-332, L-82, H-68 AND H-120, M-20 AND U-66. Add the following:

The A.S.M.E. Boiler Construction Code is copyrighted by The American Society of Mechanical Engineers. Permission will be given by the Society to use the Code symbol designated in this Code on vessels built according to the Code and a steel stamp for applying the symbol may be purchased from the Society by any manufacturer who makes affidavit that any vessel bearing the Code symbol and his name or trademark will be fully constructed in accordance with the A.S.M.E. Code and that he will not misuse or allow others to use the stamp issued to him.

TABLES P-7 AND U-3. Add the following footnote:

For steels of a higher tensile strength than 55,000 lb per sq in., the minimum of the specified range of tensile strength of the material in pounds per square inch to be used in this table is that for the steel in its annealed condition.

SPECIFICATION S-15. To make these specifications identical with A.S.T.M. Specifications A 47-33 for Grade No. 35,018 only revise Par. 2 to read:

2. *Tension Tests.* *a* The tension-test specimens specified in Par. 4 shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in........53,000 [50,000]
Yield point, min., lb. per sq. in.......35,000 [32,500]
Elongation in 2 in., per cent 18.0.... [10.0]

b The yield point DEFINED AS THAT LOAD UNDER WHICH THE SPECIMEN HAS AN ELONGATION IN 2 IN. OF 0.01 IN., may be determined by the drop of the beam or HALT IN THE GAGE of the testing machine, or by the divider method.

PARS. H-43 AND H-96. Revise to read: *(See next column)*

TABLE P-5 REVISED:

H-43 (H-96). Each steam boiler shall be provided with one or more safety valves of the spring pop type, adjusted and sealed to discharge at a pressure not to exceed 15 lb per sq in. SEALS SHALL BE ATTACHED IN A MANNER TO PREVENT THE VALVE BEING TAKEN APART WITHOUT BREAKING THE SEAL. No safety valve for a steam boiler shall be smaller than ¾ in., except in case the boiler and radiating surfaces are ASSEMBLED IN A self-contained UNIT. No safety valve shall be larger than 4½ in.

PAR. U-66. Insert the following after the first sentence:

IF THE VESSEL IS TO BE OPERATED AT TEMPERATURES EXCEEDING 700 DEG FAHR, THE MAXIMUM TEMPERATURE CORRESPONDING WITH THE MAXIMUM ALLOWABLE WORKING PRESSURE SHALL ALSO BE STAMPED ON THE VESSEL.

PAR. U-77. Revise third section to read:

The maximum allowable working pressure [for the hydrostatic tests] as determined by the formula in Par. U-20 AND USED IN DETERMINING THE HYDROSTATIC TEST PRESSURES shall be that at NORMAL atmospheric temperature and based on the actual dimensions and plate thicknesses REQUIRED FOR THE PRESSURE AND TEMPERATURE THAT ARE TO BE STAMPED ON [of] the vessel.

IN CASE THE VESSEL IS NOT TO BE OPERATED AT TEMPERATURES OVER 700 DEG FAHR, THE HYDROSTATIC TEST PRESSURES SHALL BE BASED ON THE MAXIMUM ALLOWABLE WORKING PRESSURE TO BE STAMPED ON THE VESSEL.

IN CASE THE VESSEL IS TO BE OPERATED AT TEMPERATURES EXCEEDING 700 DEG FAHR, THE HYDROSTATIC TEST PRESSURES SHALL BE BASED ON THE MAXIMUM ALLOWABLE PRESSURE TO BE STAMPED ON THE VESSEL INCREASED BY THE RATIO OF THE ALLOWABLE TENSILE STRESS AT 700 DEG FAHR, FOR THE MATERIAL USED AND THE CORRESPONDING ALLOWABLE STRESS AS GIVEN IN TABLE U-3, INTERPOLATED IF NECESSARY, FOR THE MAXIMUM WORKING TEMPERATURE TO BE STAMPED ON THE VESSEL.

FOR EXAMPLE, VESSEL TO BE STAMPED 200 LB, 900 DEG FAHR, BUILT OF 55,000-LB STEEL:

ALLOWABLE STRESS AT 700 DEG FAHR....	=	11,000 LB
ALLOWABLE STRESS AT 900 DEG FAHR....	=	5,500 LB
MAXIMUM ALLOWABLE PRESSURE AT NORMAL ATMOSPHERIC TEMPERATURE 200 × 11,000/5,500	=	400 LB
HYDROSTATIC PRESSURE DURING HAMMER TEST 400 × 1½..................	=	600 LB
HYDROSTATIC PRESSURE FOLLOWING HAMMER TEST 400 × 2..............	=	800 LB

FIG. U-7. Include provision for stamping of the temperature if it exceeds 700 deg fahr.

PAR. U-64. Insert the proposed revision of the third section of Par. U-77 as the second section of Par. U-64, except that in the example make the next to the last line read: "Hydrostatic Test Pressure 400 × 1½ = 600 lb," and omit the last line entirely.

TABLE P-5 REVISED:

TABLE P-5 MAXIMUM ALLOWABLE WORKING PRESSURES FOR STEEL OR WROUGHT IRON TUBES OR FLUES FOR FIRE-TUBE BOILERS, FOR DIFFERENT DIAMETER AND GAGES OF TUBES, CONFORMING TO THE REQUIREMENTS OF SPECIFICATIONS S-17

	Minimum Gage — B.W.G.									
	13	12	11	10	9	8	7	6	5	4
Outside diam. tube in., D	t = 0.095	t = 0.109	t = 0.120	t = 0.134	t = 0.148	t = 0.165	t = 0.180	t = 0.203	t = 0.220	t = 0.238
1	420	616	770	966	...	...	...	....	....	....
1½	280	410	513	643	774	933	...	....	....	....
1¾	240	352	440	552	663	800	920	1102	1240	1382
2	210	308	385	483	581	700	805	966	1083	1210
2¼	186	274	342	429	516	622	715	858	964	1076
2½	168	246	308	386	465	560	644	772	867	968
3	140	205	256	322	387	466	536	644	723	806
3¼	129	189	237	297	357	430	495	594	667	745
3½	120	175	220	276	332	400	460	551	620	692
4	...	154	192	241	290	350	402	482	542	605
4½	...	136	171	214	258	311	357	429	481	538
5	...	123	154	193	232	280	322	386	433	484
5⅜	...	...	143	179	216	260	299	359	404	450
5½	...	...	140	175	211	254	292	351	394	440
6	...	...	...	161	193	233	268	322	361	403

$$P = \frac{(t - 0.065)}{D} 14{,}000$$

where P = maximum allowable working pressure, lb per sq in., t = minimum wall thickness, in. and D = outside diameter of tubes, in.

TABLE L-2 REVISED:

TABLE L-2 MAXIMUM ALLOWABLE WORKING PRESSURE FOR STEEL OR WROUGHT-IRON TUBES OR FLUES FOR FIRE-TUBE BOILERS, FOR DIFFERENT DIAMETERS AND GAGES OF TUBES, CONFORMING TO THE REQUIREMENTS OF SPECIFICATIONS S-17

	13	12	11	10	9	8	7	6	5	4
Outside diam. tube in., D	t = 0.095	t = 0.109	t = 0.120	t = 0.134	t = 0.148	t = 0.165	t = 0.180	t = 0.203	t = 0.220	t = 0.238
1	466	683	854	...	...	...	...	...	...	...
1½	311	456	570	714	860	...	...	...	...	...
1¾	266	391	488	613	737	888	...	...	...	...
2	233	342	427	536	645	777	894	...	...	...
2¼	207	304	380	476	573	690	794	953	...	...
2½	186	273	342	429	516	622	715	857	964	1076
3	155	228	285	357	430	518	596	715	804	897
3¼	143	210	263	330	397	478	550	660	741	828
3½	133	195	244	306	368	444	511	613	688	769
4	...	171	213	268	322	388	447	536	602	672
4½	...	152	190	238	286	345	397	477	535	598
5	...	...	171	214	258	311	357	429	482	538
5⅜	...	...	159	199	240	289	332	398	447	500
5½	...	...	155	195	234	282	325	390	438	490
6	...	...	142	178	215	259	298	357	401	448

$$P = \frac{(t - 0.065)}{D} 15{,}550$$

where P = maximum allowable working pressure, lb. per sq. in., t = minimum wall thickness, in. and D = outside diameter of tubes, in.

Portable Shears for Sheet Metal

The portable Stanley-Unishear recently brought out by the Stanley Electric Tool Division, New Britain, Conn., cuts up to 14 gage hot rolled steel, other materials in proportion, at a speed up to 15 feet per minute and weighs only 19½ pounds. It cuts straight lines, curves, angles and notches with accuracy. In cutting curves it can operate with a minimum radius of 2½ inches either right or left hand. Inside cuts can be made by punching a 3-inch hole and slipping the yoke through. With this tool large sheets can be cut and trimmed

Stanley-Unishear No. 144

and turned-up edges cut off close to the surface on the job. By carrying the machine to the work instead of the work to the machine cutting time and expenses are reduced.

Among its mechanical features are a powerful universal motor and a steel worm mounted on seal type ball bearings; bronze worm gear and heavy alloy steel eccentric shaft mounted on ball bearings; gear case, sealed against oil leakage and entrance of dirt, with mechanism enclosed in a continuous oil bath; aluminum alloy housing of compact design; blades easily removed for sharpening; heat-treated steel yoke with micrometer blade clearance adjustment. The No. 144 Stanley-Unishear is furnished for either 110, 220 or 250 volts, as specified.

Simplified Practice Recommendation for Steel Barrels and Drums

The Division of Simplified Practice of the National Bureau of Standards has announced that Simplified Practice Recommendation R20-28, Steel Barrels and Drums, has been reaffirmed again by the standing committee of the industry.

This simplification program, which was proposed and developed by the industry, establishes a recommended schedule of stock types and capacities. The original recommendation became effective January 1, 1925. It was revised January 1, 1928 and reaffirmed in 1929, 1931 and again this year.

Copies of the recommendation may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Manager of Railroad Sales for Youngstown Company

John M. Mulholand, formerly special representative of railroad sales of The Youngstown Sheet & Tube Company, has recently been appointed manager of railroad sales for the company. Mr. Mulholand's headquarters will continue to be Chicago.

Mr. Mulholand was born in Pittston, Pa. He attended grammar and high schools in that state, and was a member of the class of 1910, University of Michigan, Marine Engineering Course. From 1910 to 1917 Mr. Mulholand followed engineering, principally mining work, and then served in the war, entering the service through the Officers Training School Tank Corps.

From the close of the war to 1932 he was actively engaged in the railroad equipment field first as district sales manager of Mudge & Company, and then as vice-president of sales of the O. F. Jordan Company. Mr. Mulholand has been with the Youngstown Sheet & Tube Company since December, 1932.

Assistant Appointed to President of Lukens Steel Company

W. A. Hauck has been appointed assistant to the president of Lukens Steel Company, Coatesville, Pa. He is a graduate of Lafayette College with the degree of min-

ing engineer and was formerly assistant comptroller of the Bethlehem Steel Corporation. Subsequently, he was connected with George W. Goethals, Inc., in company management and engineering work, and was also associated for several years with a New York stock exchange firm in underwriting and reorganization work. Prior to joining Lukens, he was with the American Iron & Steel Institute, engaged in work in connection with the code of the iron and steel industry.

Tool Builders to Hold Extensive Exposition

The National Machine Tool Builders Association is holding next fall the largest exposition in its history in Cleveland, covering some six acres of space in the Cleveland Auditorium. This exposition will be, as a matter of fact, the largest in area held during 1935 . . . however, its primary significance is not quantitative. It rests in the Machine Tool Show's being America's actual first review of her own primary mechanical efficiency since the beginning of the depression.

The Association has been gathering facts and figures concerning the industry which pertain to the status of the machine today—its new functions, relevancies, effects, potentialities.

W. L. Trout has been appointed general master mechanic of the Minneapolis & St. Louis with headquarters at Minneapolis, Minn. The positions of superintendent of motive power and rolling stock and of master mechanic, which have been held by H. W. Johnson and L. M. Chapman respectively have been abolished.

Boiler Maker and Plate Fabricator

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Request for change of address should reach us on or before the 15th of the month preceding the issue with which it is to go into effect. It is difficult and often impossible, to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address, please be sure to send us your old address as well as the new one.

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EDITORIAL STAFF: H. H. Brown, Editor. L. S. Blodgett, Managing Editor.

Contents

Trade Publications

TRANSFORMERS.—Air-cooled transformers for lighting and power service are described in detail and illustrated in a bulletin issued by the General Electric Company, Schenectady, N. Y.

HYDRAULIC EQUIPMENT.—The Seamless Steel Equipment Corporation, New York, has issued a pamphlet entitled "Hydraulik Accumulators." This describes briefly the advantages and the method of operation of hydraulic compressed air accumulators without pistons or floats. This company constitutes the sales agency in the United States for products of the Hydraulik G.m.b.H of Duisburg (Germany).

FURNACE LININGS AND ARCHES.—The design, installation and service advantages for modern boiler appliances of refractories produced by the McLeod & Henry Company, Troy, N. Y., are outlined in detail in a bulletin issued by the company.

INDUSTRIAL CABLE.—The General Electric Company, Schenectady, N. Y., has issued a new publication describing and listing all standard types of insulated wire and cable used by industrial concerns for transmission, distribution and control.

WORLD'S LARGEST PLATE MILL.—A pictorial summary of the work of Lukens Steel Company and its divisions, By-Products Steel Corporation and Lukenweld, Inc., Coatesville, Pa., is contained in a publication recently issued under the title "World's Largest Plate Mill."

LOW PRESSURE AIR.—Under the title "Low Pressure Air vs. Compressed Air for Rivet Heating Forges," the Mahr Manufacturing Company, Minneapolis, Minn., has issued technical bulletin No. 7 which contains extensive descriptive material, tabular data and calculations showing the economies which may be expected by use of modern low-pressure equipment.

IMPACT WRENCH.—A folder describing the Pott impact wrench, which is claimed to be the greatest invention of all time for shop work, has been issued by Ingersoll-Rand Company, New York. A description of this wrench is given elsewhere in this issue. The folder illustrates many applications of the use of this tool, particularly in locomotive boiler work. The impact feature enables the wrench to handle harder work than any other device for this purpose. The safety features incorporated eliminate danger of injury to the operator.

TYPE-E STOKER.—A catalogue describing the type-E center-retort underfeed stoker has been issued by the Combustion Engineering Company, New York. To date over 11,000,000 square feet of boiler heating surface have been fired with this stoker. The catalogue contains a complete description of every phase of its construction, operation and control. An introductory chapter discusses the economics of purchasing stokers and numerous diagrams showing typical ash pit and air duct arrangements as well as applications of various types of boilers.

ROTARY TOOLS.—The Chicago Pneumatic Tool Company, New York, has issued a bulletin describing and illustrating air tools, such as drills, grinders, wrenches, etc., in which the "Power Vane" rotary principle is embodied. These tools, it is claimed, have been so perfected by engineers of the company that they develop more horsepower per pound of weight than any other similar tools of equal capacity. The construction is extremely simple, having no pistons, toggles or crank shafts. The tools are light in weight, powerful and vibrationless.

ENDURO 18-8.—The Republic Steel Corporation, Central Alloy Division, Massillon, O., has issued a new edition of the subject booklet containing the latest authentic data on the various members of the Enduro 18-8 family of stainless steels. Information is included on the following: Enduro 18-8, Enduro 18-8-S, Enduro 18-8-STi, Enduro 18-8-SMO, Enduro 18-8-B and Enduro 18-8-FM. An important feature of this booklet is a table showing the degree of corrosion resistance exerted by Enduro stainless steel, types 18-8, S and AA in the presence of several hundred individual chemicals, solutions and other reagents.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on practical boiler shop problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given special permission to do so.

By George M. Davis

Conical Roof Support Calculations

Q.—On a tank 35 feet diameter and 10 feet high the roof is conical, rising 3 feet in center and is made of ¼-inch plate. This tank is to operate at a vacuum of 30 inches of water. How many 7-inch channel rafters will be required to support this roof and what diameter pipe will support the rafters at center if there is a support plate 3 feet diameter on top of pipe? T. J. G.

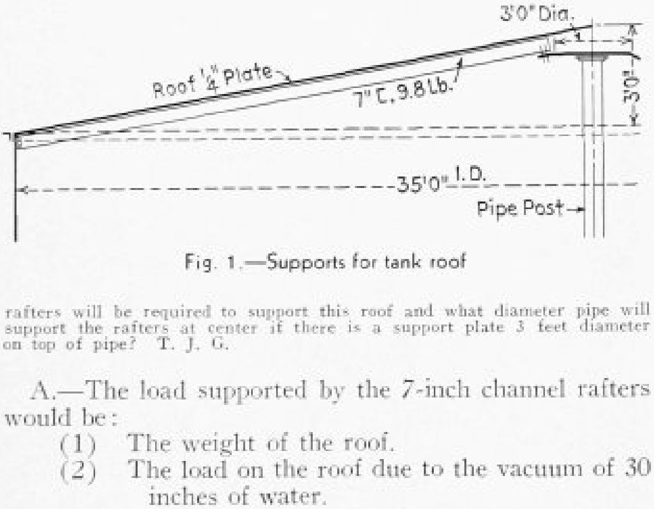

Fig. 1.—Supports for tank roof

A.—The load supported by the 7-inch channel rafters would be:

(1) The weight of the roof.
(2) The load on the roof due to the vacuum of 30 inches of water.

(1) The weight of the roof would be:

$$W = A \times t \times 0.2833,$$

where:

W = weight of roof in pounds
A = surface area of roof in square inches
t = thickness of roof, inches
0.2833 = weight of one cubic inch of steel, pounds

$$A = 3.1416\, r \sqrt{r^2 + h^2}$$

where:

r = radius of base in inches
h = height of roof in inches

Substituting values given in Fig. 1

$$A = 3.1416 \times 210 \sqrt{(210)^2 + (136)^2}$$

$$A = 660 \sqrt{45{,}396}$$

$$A = 660 \times 213$$

$$A = 140{,}580 \text{ square inches}$$

$$W = 140{,}580 \times 0.25 \times 0.2833$$

$$W = 9956 \text{ pounds}$$

(2) The load on the roof due to a vacuum of 30 inches of water.

The pressure due to a vacuum of 1 inch of water = 0.036 pound

Standard Pipe Columns

(Loads in tons of 2000 pounds, based on New York Building Code)

$S = 15{,}200 - (58\, l/r)$

S = allowable compressive stress for steel, pounds per square inch.
l = length of column, inches.
r = least radius of gyration, inches. $\frac{1}{4}\sqrt{D^2 + d^2}$.

Length Feet	Size of Pipe, Inches: 3	4	5	6	7	8	9	10	11	12	13	14	15
Thickness, Inches	0.216	0.237	0.258	0.280	0.301	0.322	0.342	0.365	0.375	0.375	0.375	0.375	0.375
24	....	....	13.55	21.66	30.32	39.96	50.44	63.43	74.03	82.98	94.17	103.02	112.08
22	....	8.02	15.15	23.39	32.18	41.95	52.55	65.69	76.35	85.30	96.49	105.44	114.40
20	....	9.49	16.74	25.12	34.04	43.94	54.66	67.94	78.67	87.62	98.81	107.76	116.71
18	....	10.95	18.34	26.85	35.90	45.93	56.78	70.20	80.99	89.94	101.1	110.08	119.03
16	6.27	12.42	19.93	28.58	37.76	47.92	58.89	72.46	83.30	92.26	103.4	112.40	121.35
14	7.61	13.88	21.52	30.31	39.62	49.90	61.01	74.71	85.62	94.57	105.7	114.72	123.67
13	8.27	14.61	22.32	31.17	40.55	50.90	62.06	75.84	86.78	95.73	106.9	115.88	124.83
12	8.94	15.34	23.12	32.04	41.48	51.89	63.12	76.97	87.94	96.89	108.0	117.03	125.99
11	9.61	16.07	23.91	32.90	42.41	52.89	64.18	78.10	89.10	98.05	109.2	118.19	127.15
10	10.27	16.81	24.71	33.77	43.34	53.88	65.23	79.22	90.26	99.21	110.4	119.35	128.31
9	10.94	17.54	25.51	34.63	44.27	54.88	66.29	80.35	91.42	100.3	111.5	120.51	129.47
8	11.60	18.27	26.30	35.50	45.20	55.87	67.35	81.48	92.57	101.5	112.7	121.67	130.62
7	12.27	19.00	27.10	36.36	46.13	56.87	68.40	82.61	93.73	102.6	113.8	122.83	131.78
6	12.94	19.73	27.90	37.23	47.06	57.86	69.46	83.74	94.89	103.8	115.0	123.99	132.94
5	13.60	20.46	28.69	39.09	47.99	58.86	70.52	84.86	96.05	105.0	116.2	125.15	134.10

$0.036 \times 30 = 1.08$ pounds pressure due to vacuum of 30 inches of water

Load = Area of base × pressure per square inch

Area = 420-in. diameter circle = 138,544 square inches

$138{,}544 \times 1.08 \times 149{,}627$ pounds load due to pressure of 30-inch vacuum

Total load on roof equals

$149{,}627 + 9956 = 159{,}583$ pounds.

For all practical purposes the channel rafters can be considered to carry this load.

In any structural steel handbook can be found the safe loads in pounds, uniformly distributed, for any given size of channel for a given length.

A 7-inch channel, weighing 9.75 pounds per foot, with a distance between supports of 16¼ feet will carry a safe load of 3960 pounds, including the weight of the channel.

Weight of channel $9.75 \times 16.25 = 158$ pounds

$3960 - 158 = 3802$ pounds load carried by one channel

Total load on roof = 159,583 pounds

Load carried by one rafter = 3802

$$\frac{159{,}583}{3802} = 41.9 \text{ or } 42 \text{ channels required.}$$

The following table gives the permissible load in tons for various sizes and lengths of pipe columns. The load on the column can be safely taken as ⅓ of the total load.

Working Stresses in Steam Jacketed Vessel

Q.—I shall be pleased if you will show the method of calculating the working stresses, and required thicknesses, for a mild steel jacketed cone as shown in sketch herewith. E. T. A.

A.—The thickness of the outer shell of the jacketed vessel submitted with the question and illustrated in Fig. 1 can be computed from the formula for shell courses of unfired pressure vessels, computing the thickness required for the large diameter of the conical end, and using this plate thickness throughout. The formula is:

$$WP = \frac{S \times t}{R}$$

where:

WP = maximum allowable working pressure in pounds per square inch.

S = maximum unit working stress at right angles to the direction of the joint, for welded seams, as follows:

Butt double-V welds for all joints	8000 pounds
Butt single-V for girth or head welds	6500 pounds
Double full-fillet lap welds, for girth joints only	7000 pounds
Spot or intermittent girth or head welds	5600 pounds

For butt single-V longitudinal welds and for material of thickness less than ¼ inch, the maximum allowable stress shall not exceed 5600 pounds per square inch.

t = minimum thickness of shell plate in weakest course, inches

R = inside radius of the weakest course of the shell, inches, provided the thickness of the shell does not exceed 10 percent of the radius. If the thickness is 10 percent of the radius, the outer radius shall be used.

Transposing the formula, we have:

$$t = \frac{WP \times R}{S}$$

Substituting the value given in Fig. 1 we have

WP = 50 pounds

R = 20 inches

S = Fig. 1 shows that either a single or double-V weld is to be used, the allowable value for S

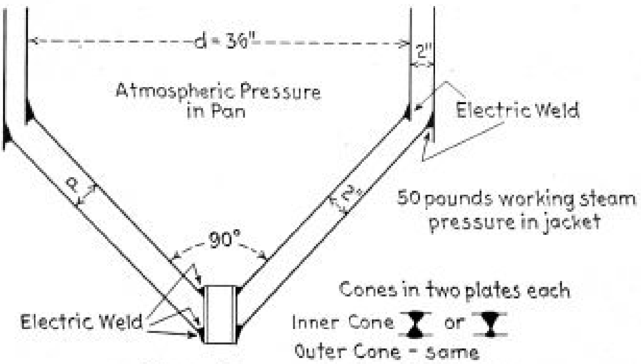

Fig. 1—Arrangement of Steel Jacketed Kettle

would therefore have to be the minimum value or 5600 pounds for a single-V weld for the longitudinal seam, provided however that the value of t is found to be ¼ inch or less. If the value of t is found to be over ¼ inch, the seam will have to be the double-V type weld.

$$t = \frac{50 \times 20}{5600}$$

$t = 0.1785$ or $\frac{3}{16}$ inch, thickness of outside shell.

The thickness of the inner shell can be computed from either of the following formulas:

(1) Where the length does not exceed 120 times the thickness of the plate;

$$T = \frac{(P \times D) + 53L}{965}$$

(2) Where the length exceeds 120 times the thickness of the plate;

$$T = \sqrt{\frac{P \times L \times D}{4250}}$$

where;

P = maximum allowable working pressure, pounds per square inch

D = outside diameter, inches

(For truncated cones, D in the formula is taken equal to the diameter at the large end.)

L = total length between center of heads seams (not length of a section), inches

T = thickness of plate, in sixteenths of an inch.

The efficiency of the longitudinal seam must be 50 percent or over.

Using a single-V weld, the maximum allowable unit working stress would be 5600 pounds. The maximum unit working stress for steel plate stamped 55,000 pounds per square inch is 11,000 pounds; the efficiency of the welded seam would be:

$$\frac{5600}{11000} = 50.9 \text{ percent}$$

Where L is over 6 diameters in length, L in the formula shall be taken as six diameters.

The sketch submitted with the question does not include the length, therefore for an example we will assume the length to be 20 inches. Using formula (2) solve for T as follows:

$P = 50,\ L = 20,\ D = 36$

$$(2)\quad T = \sqrt{\frac{P \times L \times D}{4250}}$$

$$T = \sqrt{\frac{50 \times 20 \times 36}{4250}}$$

$$T = \sqrt{\frac{36{,}000}{4250}}$$

$$T = \sqrt{8.47}$$

$T = 2.9$ sixteenths or $\frac{3}{16}$ inch thickness of inside shell.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.

Assistant Chief Inspectors—J. M. Hall, Washington, D. C.; J. A. Shirley, Washington, D. C.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Assistant Director—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.

Vice-Chairman—D. S. Jacobus, New York.

Acting Secretary—M. Jurist, 29 W. 39th Street, New York.

Honorary Secretary—C. W. Obert, New York.

National Board of Boiler and Pressure Vessel Inspectors

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Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.

Vice-Chairman—F. A. Page, San Francisco, Cal.

Statistician—L. C. Peal, Nashville, Tenn.

International Brotherhood of Boiler Makers, Welders, Iron Ship Builders and Helpers of America

International President—J. A. Franklin, Suite 522, Brotherhood Block, Kansas City, Kansas.

Assistant International President—J. N. Davis, Suite 522, Brotherhood Block, Kansas City, Kansas.

International Secretary-Treasurer — Chas. F. Scott, Suite 506, Brotherhood Block, Kansas City, Kansas.

Editor-Manager of Journal — John J. Barry, Suite 524, Brotherhood Block, Kansas City, Kansas.

International Vice-Presidents—Joseph Reed, 1123 E. Madison Street, Portland, Ore.; W. A. Calvin, 1622 Glendale Street, Jacksonville, Fla.; Harry Nicholas, 6215 S. Benton Blvd., Kansas City, Mo.; W. E. Walter, 637 N. 25th Street, East St. Louis, Ill.; J. H. Gutridge, 910 N. 18th Street, Milwaukee, Wis.; W. G. Pendergast, 26 South Street, New York, N. Y.; W. J. Coyle, 424 Third Avenue, Verdun, Montreal, Quebec, Can.; A. M. Milligan, 262 Trent Avenue, East Kildonan, Man., Can.; J. F. Schmitt, 28 S. Roys Street, Columbus, Ohio; William Williams, 502 Labor Temple, Portland, Ore.

Master Boiler Makers' Association

President—Kearn E. Fogerty, general boiler inspector, C., B. & Q. R. R., Aurora, Ill.

First Vice-President—Franklin T. Litz, general boiler foreman, Chicago, Milwaukee, St. Paul & Pacific Railroad, Milwaukee, Wis.

Second Vice-President—O. H. Kurlfinke, boiler engineer, Southern Pacific Railroad, San Francisco, Cal.

Third Vice-President — Ira J. Pool, division boiler inspector, Baltimore & Ohio Railroad, Baltimore, Md.

Fourth Vice-President—L. E. Hart, boiler foreman, Atlantic Coast Line, Rocky Mount, N. C.

Fifth Vice-President—William N. Moore, general boiler foreman, Pere Marquette R. R., Grand Rapids, Mich.

Secretary—Albert F. Stiglmeier, general foreman boiler maker, New York Central Railroad, Albany, N. Y.

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Executive Board—Charles J. Longacre, chairman, division boiler inspector, Pennsylvania Railroad, Baltimore, Md.

American Boiler Manufacturers' Association

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Vice-President—S. H. Barnum, The Bigelow Company, New Haven, Conn.

Secretary-Treasurer—A. C. Baker, 709 Rockefeller Building, Cleveland, Ohio.

Executive Committee—(Three years)—F. H. Daniels, Riley Stoker Company, Worcester, Mass.; M. E. Fink, Murray Iron Works, Burlington, Iowa; A. G. Pratt, Babcock & Wilcox Company, New York. (Two years) —R. B. Mildon, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.; A. W. Strong, Strong-Scott Manufacturing Company, Minneapolis, Minn.; R. B. Dickson, Kewanee Boiler Corporation, Kewanee, Ill. (One year)—A. C. Weigel, Combustion Engineering Corporation, New York; Walter F. Keenan, Jr., Foster Wheeler Company, New York; G. S. Barnum, The Bigelow Company, New Haven, Conn. (Ex-Officio)—Charles E. Tudor, The Tudor Boiler Manufacturing Company, Cincinnati, Ohio.

Office of Industrial Recovery Committee,
15 Park Row, New York

Manager—James D. Andrew.

Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President—Murrel J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

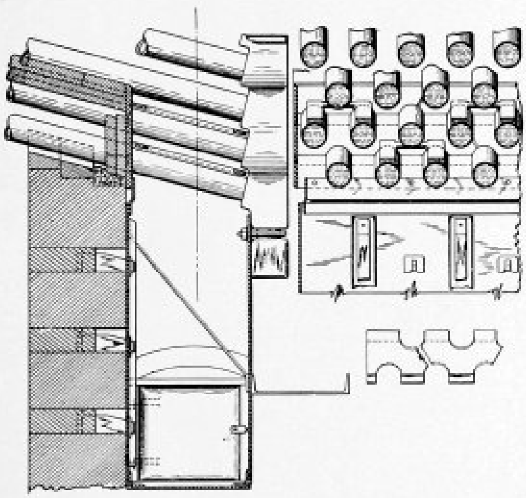
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent Attorney, 1372-1376 National Press Building, Washington, D. C. Readers wishing copies of patents or any further information regarding any patent described, should correspond directly with Mr. Galt.

1,859,873. SOOT POCKET FOR BOILERS. DAVID S. JACOBUS, OF MONTCLAIR, NEW JERSEY, AND WILLIAM A. JONES, OF WEST NEW BRIGHTON, NEW YORK, ASSIGNORS TO THE BABCOCK AND WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

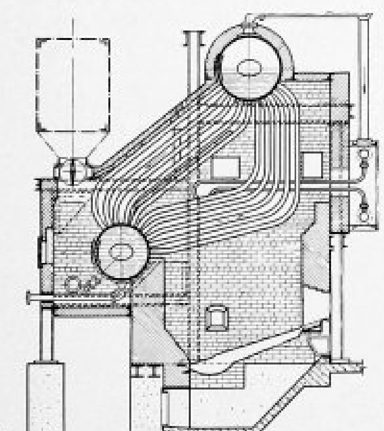
Claim.—In combination, a water tube boiler having inclined tubes connected to a header at one end, a furnace having a wall spaced inwardly



from said header, whereby a length of tubes is situated between the wall and the header, means providing gas passes across said tubes with the lower end of one pass including said length of tubes, a soot box disposed beneath said length, and a gas tight expansion joint between the parts of the boundary wall of said socket. Eleven claims.

1,859,858. BOILER. PAUL WRIGHT, OF BIRMINGHAM, ALABAMA.

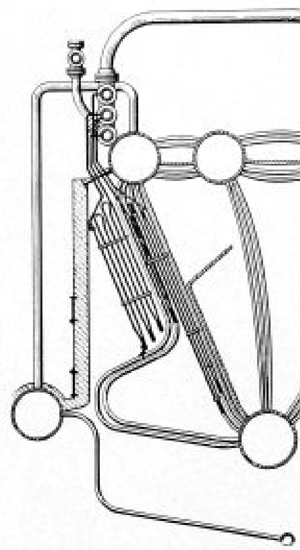
Claim.—In a boiler, the combination of a water drum arranged at the rear of the fire grate, a steam drum arranged above and forward of the



water drum, a bank of tubes extending at an acute angle upward and forward from the water drum and then approximately vertically upward to the steam drum, a second bank of tubes extending from the lower rear portion of the steam drum to the water drum, and a baffle supported beneath and adjacent to said second bank and extending from the water drum along said second bank and toward but not to the steam drum. Nineteen claims.

1,858,872. COMBINED SUPERHEATER AND BOILER. WILBUR H. ARMACOST, OF NEW YORK, N. Y., ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y.

Claim.—The combination of a furnace, a boiler heated thereby, two groups of superheater elements, one of which is arranged to receive a relatively large amount of radiant heat from said furnace as compared to



the other, said other group of superheater elements so arranged with respect to said boiler and furnace that the percentage of its surface in the stream of combustion gases from the furnace increases automatically with increase in rate of operation of the furnace, and connections leading steam from the boiler first through said radiant group of elements and then through said other group. Fourteen claims.

Boiler Maker and Plate Fabricator

Boiler Manufacturers' Annual Meeting

The secretary of the American Boiler Manufacturers' Association and Affiliated Industries has recently sent out an announcement that the annual meeting of the association will be held at The Lodge of Skytop Club, Skytop, Pa., on June 10 to 12.

The program of the meeting has not as yet been completely arranged but it is important that all member companies plan to be represented since this meeting, as those in recent years, will have a marked bearing on the conduct of the industry during the coming months. Details of the program will be published in a later issue.

Materials for Plate Fabrication

In the fields of boiler manufacturing and plate fabrication, particularly the latter, the refinement of older materials and the development of new special quality materials make possible advances in the design and construction of all manner of industrial structures.

In the class of refined materials, none has been of greater value than wrought iron in recent years, since modern production methods have made its use economically possible in structures where full advantage can be taken of its special qualities.

In storage tanks, stacks, uptakes, and a wide range of vessels of all kinds where resistance to corrosion is of primary importance, wrought iron plate has found many applications. It is only since 1930 that this material has been available commercially in the form of plates in sizes to meet modern requirements. Many concerns, therefore, may not be entirely familiar with the most efficient practices for bending and forming such plates.

The article on this subject, elsewhere in this issue, should be found extremely useful by our readers engaged in the fabrication of structures where wrought iron plates are used. Actually the differences in methods between bending wrought-iron and steel plates are very slight. These differences, however, determine the ease and success of the bending operations and should be studied carefully both by the designer, who specifies wrought iron plate, and by the fabricator, who carries out the actual work. No change in equipment is required, the differences being solely in method.

In the field of high tensile corrosion resisting steel, Cor-Ten, also discussed in this issue, offers a wider range of applications than has been possible in the past, since the price differential between it and open-hearth steel has been greatly decreased. In many types of pressure vessels, chemical vessels, stills, tanks, car bodies, and the like, where resistance to corrosion is a highly desirable quality but does not warrant the use of costly high chromium steels, or nickel clad steel, this new material will undoubtedly find a wide use.

In spite of its high tensile characteristics, Cor-Ten can be worked with but slight changes from the common practices followed with low carbon steel. The outline of test results given for hot and cold forming, drilling, punching, reaming, and welding this material, indicates very generally its comparative workability with open-hearth steels.

Have Mechanical Associations Outlived Their Usefulness?

The future of the Master Boiler Makers' Association, together with that of all of the lesser railway mechanical associations, seems to be hanging in the balance at the present moment. All of these independent railway associations have contributed to the successful operation of the railroads of the country in the past, but now when their most useful work could be accomplished, encouragement for their continuance is entirely lacking.

Naturally, when, under stress, the major associations slowed down their convention programs, these minor mechanical associations suffered even more severely. Some of them have not held meetings for several years, the Master Boiler Makers Association for example not since 1930, and their memberships have been hard hit because of changes which have taken place in personnel. At the meeting of the General Committee of the Mechanical Division of the Association of American Railroads, last June, its members felt so strongly about the value of conventions of these organizations, that it was decided to encourage them at least partly to resume their former activities. In September, representatives of the various associations met in Chicago and decided tentatively to hold conventions early in May of this year, four of the associations meeting individually and simultaneously on the last three days of one week, and four on the first three days of the following week. It was decided, also, by the allied railway supply groups to have a common exhibit for all of the meetings.

Railroad business, however, has not improved as greatly as had been anticipated and the formation of the Association of American Railroads has apparently complicated the problem of non-official bodies. As a result, uncertainty existed until recently as to whether or not the associations would be able to hold the conventions in May. The officers of the minor mechanical associations looked to the Mechanical Division for advice, and this division, in turn, looked to the officers of the Association of American Railroads for guidance.

The officers of the minor mechanical associations were disturbed a few days ago to receive a letter from J. R. Downs, vice-president in charge of operation of the Association of American Railroads, which said:

"Our Association has not absorbed the associations enumerated in your letter, and from the standpoint of the activities of the Association of American Railroads, there is no necessity for holding any conventions such as you have enumerated.

(Continued on page 93)

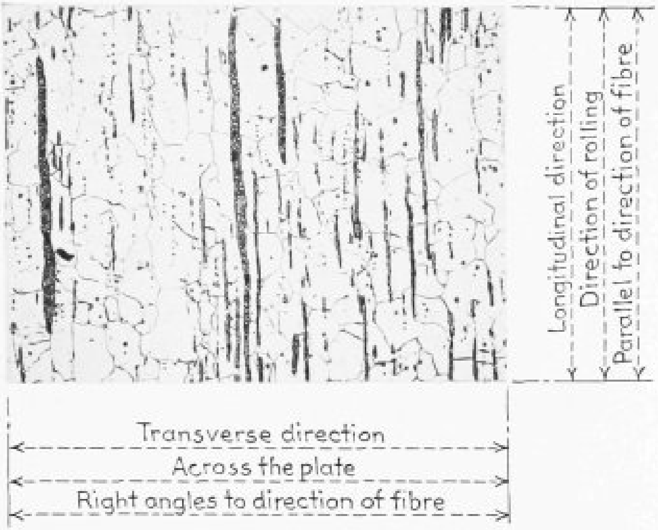


Fig. 1.—Photomicrograph (100 magnifications) showing structure of wrought iron, and plate bending terms used in text of article

Bending Wrought Iron Plates*

Successful bending of any ductile plate material, such as wrought iron or steel, depends to a great extent upon the fabricator's knowledge of the structure of the metal, its physical characteristics, and the limitations imposed by the bending equipment available. Since many different methods are employed in bending plates, it is the purpose of this article to discuss in a clear and concise manner the ones that have been found most satisfactory for use when bending wrought-iron plates.

For almost a quarter of a century prior to 1930, plates made of wrought iron were not produced in commercial quantities. As a result, there are undoubtedly many fabricators today who are not thoroughly familiar with wrought iron and the differences between it and steel. For this reason, it is necessary to preface the discussion of plate bending principles and practices with a statement of two important facts and a brief description of wrought iron, its properties and characteristics.

1.—Wrought iron plates may be formed just as satisfactorily as steel plates if the fabricator observes the slight modifications in bending practice that are fully described in the following pages.

2.—The equipment employed in forming or bending wrought-iron plates is the same as that commonly used for steel plates. No special equipment is required.

Wrought iron is composed of two dissimilar materials, namely, (1) a high purity iron base metal, and (2) iron silicate or slag. The slag, a non-rusting, glass-like substance, is finely divided throughout the base metal in the form of threads or fibres which extend in the direction that the material is rolled. Wrought iron is the only metal that contains these iron silicate fibres.

The slag content, which amounts to about 3 per cent by weight of the total, confers on wrought iron a distinctly fibrous structure. This characteristic of the metal is very much in evidence when a specimen is nicked and fractured.

The fibrous structure of wrought iron may, for the purpose of comparison, be likened to the structure of hickory wood, with which everyone is familiar. It is generally known that a hickory plank can be bent to a short radius without danger of breaking if the line of bend (or axis of bend) is at right angles to the grain. However, if the same plank is bent with the bend line parallel to the grain the radius of bend must be increased somewhat in order to keep the plank from splitting. The grain of the wood is responsible for this difference in "bendability."

The slag fibres in wrought iron affect its bendability in much the same manner that the grain affects the bendability of hickory wood. Therefore, it follows that a wrought-iron plate can be bent to a shorter radius when the line of bend (or axis of bend) is at right angles to the direction of the slag fibres than when the bend line is parallel to the fibre direction.

From this comparison it is apparent that the slag fibres in wrought iron have a direct effect on the

* An article prepared by the Engineering Service Department of the A. M. Byers Co., Pittsburgh, Pa.

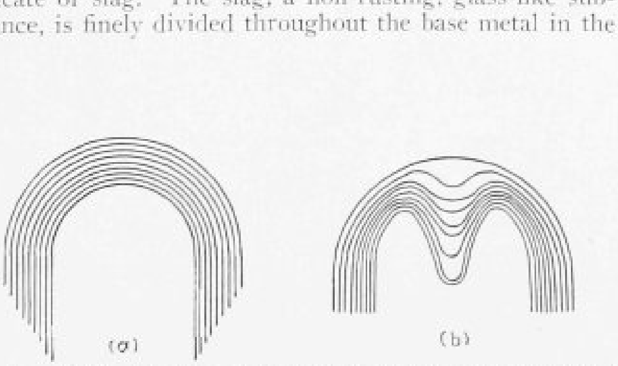


Fig. 2.—(a) This illustrates what would happen if all sections of a plate were free to move using a deck of cards to simulate the plate—(b) When the ends are gripped tightly the inside fibers must buckle when bent unless the outside fibers stretch

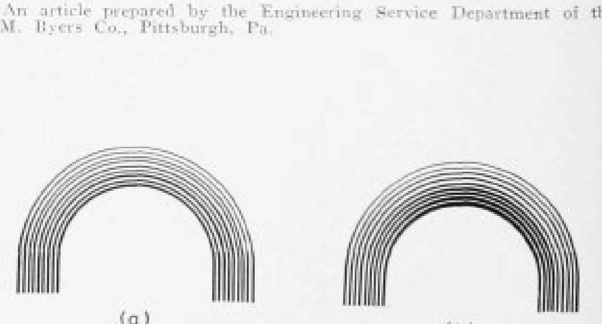


Fig. 3.—(a) Illustrating action of elastic parts each free to stretch individually—(b) If deck were gripped tightly at ends and then bent, outer cards would thin out and inner ones, instead of buckling, would compress and thicken

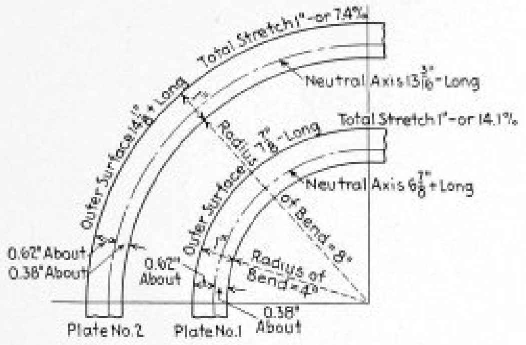


Fig. 4.—The influence of the radius of bend on "bendability"

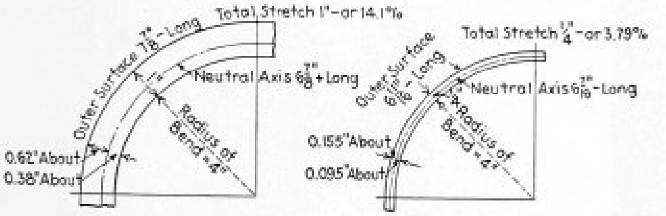


Fig. 5.—The influence of plate thickness on "bendability"

Note:—A comparison of the two sketches reveals that the ¼-inch plate could be bent to a radius of 1 inch before the stretch in the outer surface would equal that which occurred in the outer surface of the 1-inch plate bent to a 4-inch radius.

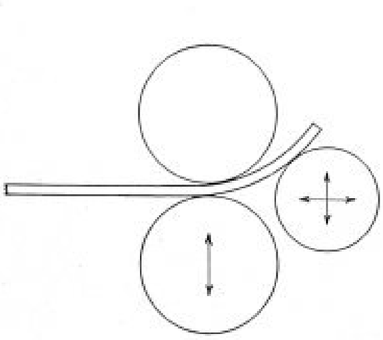


Fig. 7.—Illustrating the principle of the initial roll bender

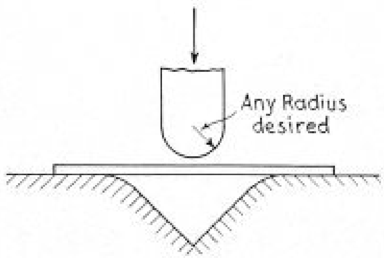


Fig. 8.—How plates are formed with V-block and hammer

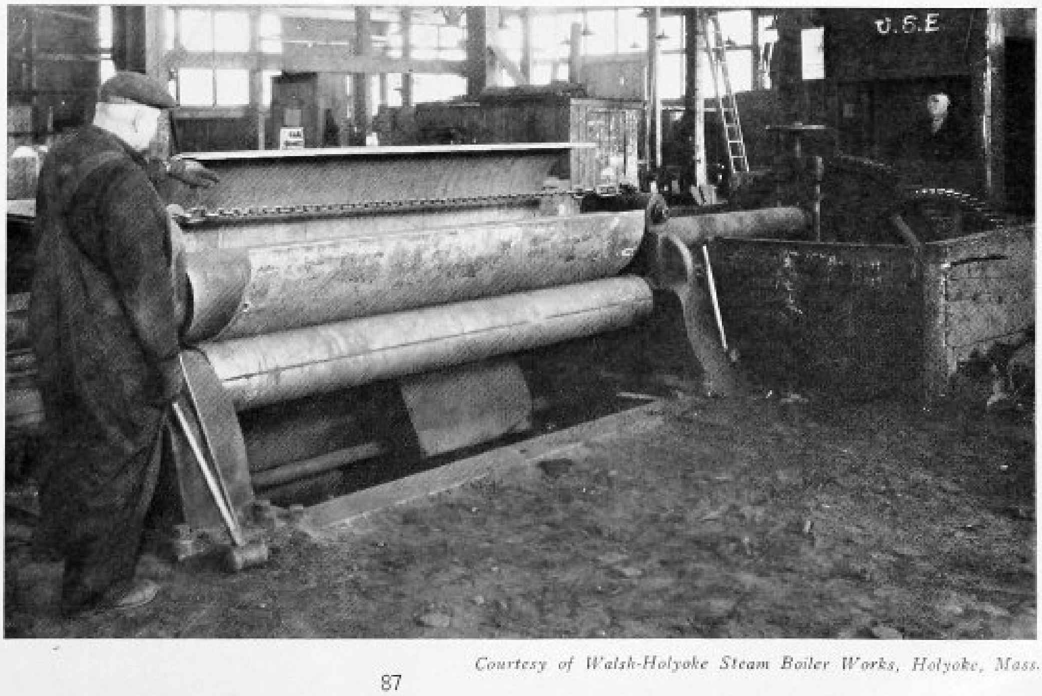
ductility of the material. This effect, however, is more noticeable in the transverse direction (across the plate) than it is in the longitudinal direction (lengthwise of the plate).

The reason for this difference in ductility in the two directions is that the slag fibres make the metal discontinuous in the transverse direction. This characteristic of the material is clearly illustrated by the photomicrograph shown in Fig. 1. This photomicrograph was taken at 100 magnifications and the slag fibres are most apparent. For the sake of clarity some of the terms used in this discussion of plate bending are indicated on Fig. 1.

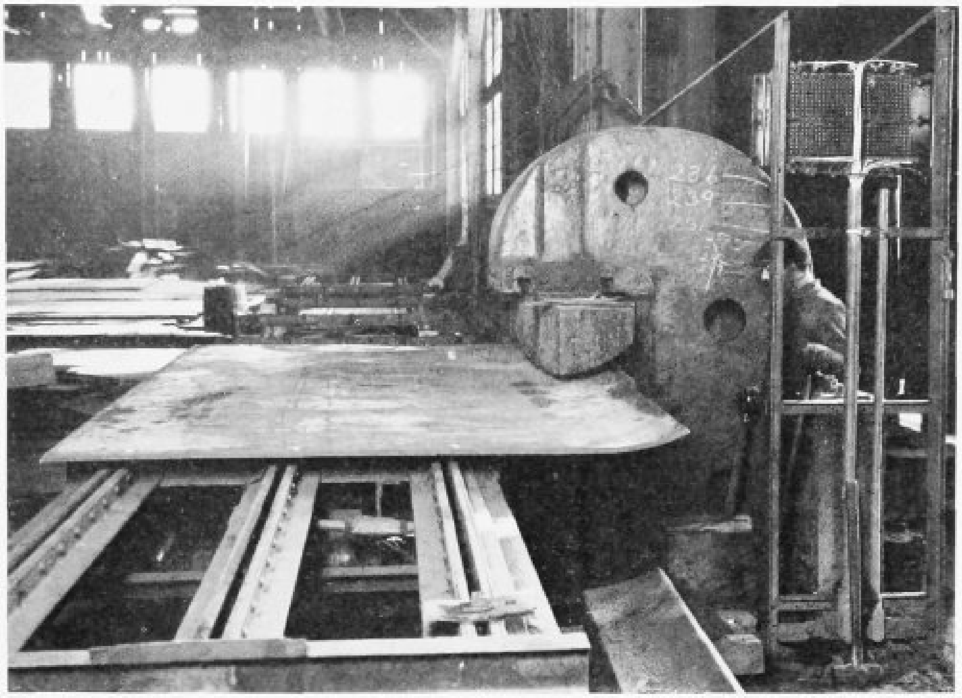
Since ductility is the most important property of a material from the standpoint of "bendability" it should be mentioned that for standard wrought-iron plates the minimum ductility in the transverse direction is 2 per cent in 8 inches, while in the longitudinal direction the minimum ductility is 14 per cent in 8 inches. These values are somewhat less than those shown by other ductile non-slag-bearing metals, such as steel.

From the foregoing facts, it is evident that wrought

Fig. 6.—Wrought iron plates ¾ inch thick being formed in a roll bender for fabrication into large O.D. pipe

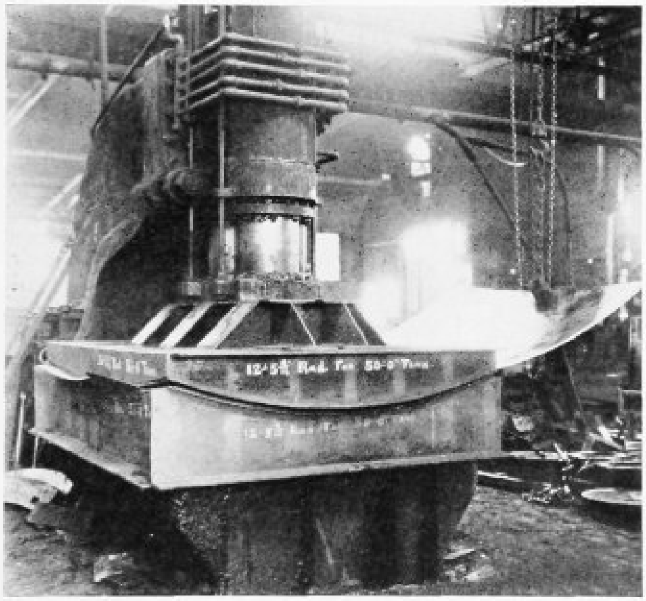


Courtesy of Walsh-Holyoke Steam Boiler Works, Holyoke, Mass.



Courtesy of Walsh-Holyoke Steam Boiler Works, Holyoke, Mass.

Fig. 9.—Crimping the edge of a $\frac{3}{4}$-inch wrought iron plate, an operation carried out on the gag press



Courtesy of Pittsburgh-Des Moines Steel Company, Pittsburgh, Pa.

Fig. 10.—Press equipped with welded structural dies for bending plates to a longitudinal radius of 12 feet $5\frac{5}{8}$ inches, and a transverse radius of 35 feet $3\frac{1}{8}$ inches

iron is an entirely different material from any of the other commonly used ferrous metals. Consequently, when bending wrought iron, its directional properties must be taken into consideration.

When wrought iron plates were reintroduced to the market in 1930, the A. M. Byers Company realized the limits that low transverse ductility might impose on the applications of the material. Consequently, extensive research and experiments led to the development of special rolling procedure which made possible the production of wrought-iron plates having much higher transverse ductility than those produced by rolling in the conventional manner. This development is particularly important because it has made possible the use of wrought-iron plates for many corrosive services where severe fabrication had formerly prevented their use.

Facts About Plate Bending

Most of the difficulties encountered in plate bending come through a lack of appreciation of what happens during the bending operation. When a plate is bent the metal must be stressed beyond its yield point. This means that the metal undergoes deformation or stretching. Therefore, since the ductility of the metal determines the amount it can be deformed before fracture occurs, it it obvious that ductility is the most important factor to be considered. Recognition of this fact, and the use of a technique that takes it into account, is the first step in successful plate bending.

The part that ductility plays may be clearly shown by an example. Take a deck of cards (a magazine or a pad of paper will also serve) and bend it into a semicircle. It will take the form illustrated in Fig. 2(a).

From inside to outside, each successive card "steps back" a greater and greater distance from the edges of the inside card.

If the deck is gripped tightly at the ends to prevent slipping and then bent, it will look like the sketch in Fig. 2(b).

The cards on the inside, restrained from pushing down, must buckle to make room. The outer card will remain unchanged.

If the cards were elastic and could stretch, the "step-back" could be squared after bending by taking each individual card and drawing it down to the level of the inner one. The stretch required would increase with each card, reaching a maximum in the card on the outside of the curve. In order to permit the stretching, the cards would thin out in the center, and the deck would present the appearance shown by the sketch in Fig. 3(a).

If this elastic deck were tightly gripped at the ends, to prevent slipping, and then bent, the cards on the outer portion of the deck would thin out. The cards on the inner portion instead of buckling, would compress

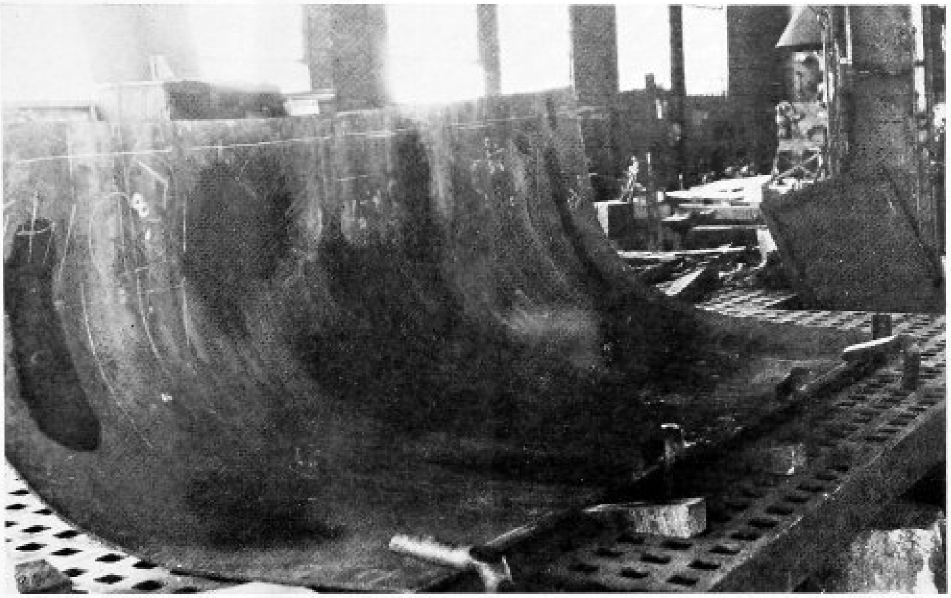


Fig. 11.—Wrought iron knuckle plate for use in a channel boat hull, being bent in one direction

Courtesy of Marietta Manufacturing Company, Point Pleasant, W. Va.

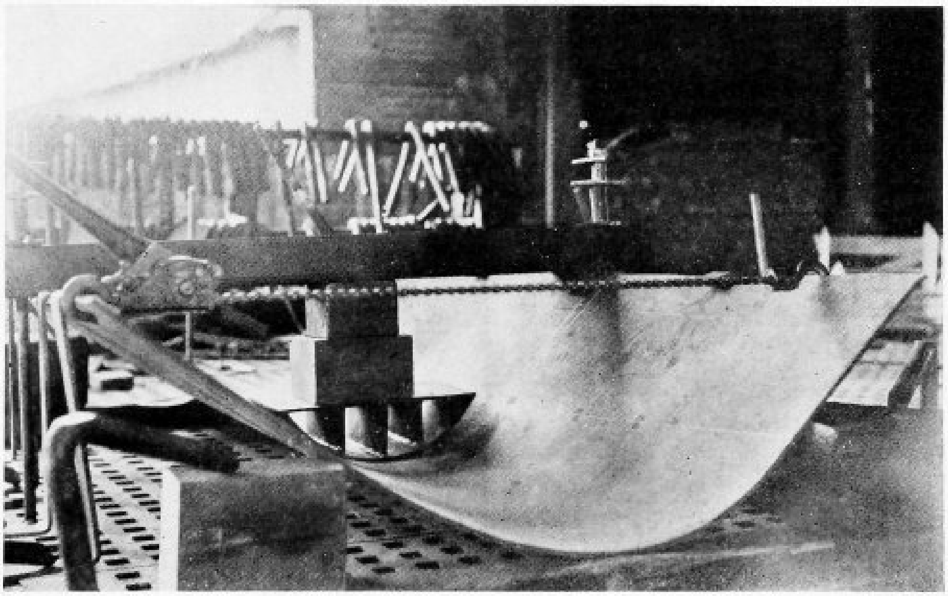


Fig. 12.—The same wrought iron knuckle plate shown above ready for the second bending operation

Courtesy of Marietta Manufacturing Company, Point Pleasant, W. Va.

and thicken. The deck would then take the form illustrated in Fig. 3(b).

Somewhere near the center of the deck there would be one card that would be neither stretched nor compressed. This card would be located at what is commonly termed the neutral axis. The exact location of the neutral axis depends upon the type of plate material being bent. With the commonly used ductile ferrous plate metals, such as wrought-iron or steel, the neutral axis will be near the inner surface of the bend because those metals have greater strength in compression than in tension.

Again referring to Fig. 3(b), if all cards in the bent deck except the top and bottom ones were taken out, then those two cards might be considered as representing the inner and outer surfaces of a bent plate. Since the metal in a plate is a unit mass, it is obvious that slip cannot occur as it can between the cards when the deck is bent. When a plate is bent the necessary change in length of the two surfaces much be produced by a lengthening or stretching of the outer surface and (to a limited extent) to a shortening of the inner surface. However, for the purpose of this discussion the shortening of the inner surface that occurs during the bending operation can be neglected.

The importance of ductility and its influence on bendability has been mentioned. It follows then that if a plate is bent so as not to exceed the ductility of the metal, the amount of stretch that occurs on the outer surface of the bend will be dependent upon two factors, namely: (1) radius of bend; (2) thickness of plate. The effect of these two factors is clearly illustrated by the sketches in Fig. 4 and Fig. 5.

Fig. 4 shows two plates of the same thickness bent to different radii. A brief study of these sketches will reveal that the outer surface of each plate has stretched or elongated the same amount—slightly less than 1 in. The reason for this is that in each case the outer surface of the plate is the same distance from the neutral axis. However, the neutral axis (which has the same length as the plate before it was bent) of plate No. 1 is appreciably shorter than the neutral axis of plate No. 2. Therefore, since the outer surfaces of the two plates have stretched the same amount, it is obvious that the percentage stretch per unit of length is much greater in Plate No. 1 than in Plate No. 2. This is clearly shown by the dimensions on the sketch.

Therefore, it can be stated that for a given plate thickness, the percentage stretch per unit of length increases as the radius of bend decreases.

The influence of plate thickness on bendability is clearly illustrated by Fig. 5 which shows two plates—one ¼-in. thick and the other 1-in. thick—bent to the same radius. It is apparent that during the bending operation the outer surface of the 1-in. plate had to stretch to a much greater extent than did the outer surface of the ¼-in. plate. Also, it will be observed that that ¼-in. plate could be bent to a much shorter radius than the 1-in. plate before the percentage stretch per unit of length in the outer surface would equal that which occurred in the outer surface of the 1-in. plate.

From these facts it can be stated that for a given radius of bend, the percentage of stretch per unit of length increases as the thickness of the plate increases.

Theoretically the degree of bend, that is, whether the bend is made through 45-deg., 90-deg., 180-deg., or 360-deg., has nothing to do with the amount that the material must stretch. From the practical standpoint, however, degree of bend does have an influence because many types of bending equipment used do not evenly distribute the stretch over the entire bent portion. For this reason the procedure followed and the equipment employed are factors that have a direct bearing on the bending of wrought-iron plates.

Principles and Practice for Cold Bending of Wrought-Iron Plates

It has already been stated that wrought iron plates, due to the presence of the slag fibres, possess directional properties. Also, that in bending wrought iron plates these properties must be taken into consideration. Recent developments made in the procedure for rolling wrought iron plates have greatly increased the ease of bending plates made of this material.

These recent developments in rolling procedure have made possible the production of wrought-iron plates possessing varying degrees of ductility in both the transverse and longitudinal directions. For example, wrought iron plates are available having a ductility in the transverse direction ranging from a minimum of 2 per cent elongation in 8 in. to a maximum of 8 per cent elongation in 8 in.

In the latest revision of the American Society for Testing Materials Specification for Wrought-Iron Plates, Designation A 42-34 T, provision is made for wrought-iron plates having varying degrees of ductility in the two directions. Table I, taken from this specification, shows the minimum ductility requirements for the various classes of plates available.

Table 1—Minimum Ductility Requirement for Wrought-Iron Plates

Transverse ductility (elongation in 8 in.) per cent		Minimum longitudinal properties: Tensile strength, min., lb. per sq. in.	Minimum longitudinal properties: Elongation in 8 in., min., per cent
2	51,000 — (1500 x 2) =	48 000* (16 — 2) =	14*
3		46 500	13
4		45 000	12
5		43 500	11
6		42 000	10
7		40 500	9
8		39 000	8

*Test requirements for the usual full longitudinal rolling of the plate.

From this table it can be seen that as the transverse ductility is increased until the minimum requirement is 8 per cent in 8 in., the ductility as well as tensile strength in the longitudinal direction decreases. Using these values as a basis, a formula has been derived for calculating the recommended radii to which wrought-iron plates of various thicknesses can be bent in the two directions. This formula, which is given as follows, provides an ample factor of safety.

$$R = \frac{62\ T}{S} - .38\ T$$

where R = Minimum radius of bend in inches
T = Thickness of plate in inches
S = Per cent elongation in eight inches

Using this formula and substituting the value for ductility that will come into play when the bend is made, the minimum radius of bend has been calculated for the several classes of plates in the various thicknesses. These values are given in Table II.

These recommended bending radii were calculated using in each case the minimum specification requirements for ductility as shown in Table I. It will be observed that the sum of the minimum transverse ductility and the minimum longitudinal ductility is always sixteen per cent. Therefore, if a plate has a minimum transverse ductility of 5 per cent, the minimum longitudinal ductility will automatically be 11 per cent.

The correct use of Table II necessitates a thorough knowledge of the relation between the bend line (axis of bend) and the direction of the fibre in the plate. For example, if a ¼-in. standard rolled plate (minimum transverse ductility 2 per cent in 8 in., minimum longitudinal ductility 14 per cent in 8 in.) is to be bent with the bend line parallel to the direction of rolling, the recommended radius of bend will be 7⅝ in. If the bend is made with the bend line at right angles to the direction of rolling, the minimum radius of bend will be 1 in. These values are obtained directly from Table II by referring to the columns opposite ¼-in. plate headed 2 per cent and 14 per cent.

However, there are conditions where a standard rolled plate with 2 per cent transverse ductility and 14 per cent longitudinal ductility can not be used because the requirements demand a shorter radius bend than the 7⅝ in. given in the preceding example. For such conditions it is obvious that the designer must select the type or class of plate that will bend to the desired radius. In other words, the plate must be specified in accordance with the ductility required to provide the necessary stretch that will occur when the bend is made.

For example, if a ⅜-in. plate must be bent, with the bend line parallel to the length of the plate, to a 2¾-in. radius, it is readily seen that this can be done only with a plate having maximum transverse ductility (that is, a transverse ductility of 8 per cent), as shown in Table II under the column headed 8 per cent, opposite ⅜-in. plate.

It should be borne in mind that there are always to be found slight variations in the physical characteristics of a material, and that differences in bending practice and equipment have a pronounced influence on the results obtained. The recommended radii of bends given in Table II, as already mentioned, are sufficiently liberal to take ordinary variations in material, practice and equipment into account.

Methods and Equipment Used in Cold Bending

Since the bending of wrought iron plates necessitates the stretching of the material, it is obvious that distribution of the stretch or elongation is of the utmost importance. Good equipment or practice will result in dis-

Table II—Recommended Bending Radii for Wrought-Iron Plates

Plate thickness T	Values of S in per cent. 2	3	4	5	6	7	8	9	10	11	12	13	14
	Minimum Bending Radii in Inches—R												
3/16	5 3/4	3 13/16	2 13/16	2 1/4	1 7/8	1 9/16	1 3/8	1 1/4	1 1/16	1	1	15/16	3/4
1/4	7 5/8	5 1/16	3 3/4	3	2 1/2	2 3/16	1 13/16	1 5/8	1 7/16	1 5/16	1 3/16	1 1/8	1
5/16	9 5/8	6 5/16	4 3/4	3 3/4	3 1/8	2 5/8	2 5/16	2 1/16	1 13/16	1 5/8	1 1/2	1 3/8	1 1/4
3/8	11 1/2	7 5/8	5 11/16	4 1/2	3 3/4	3 3/16	2 3/4	2 7/16	2 3/16	2	1 13/16	1 5/8	1 1/2
7/16	13 1/4	8 7/8	6 5/8	5 1/4	4 3/8	3 11/16	3 1/4	2 7/8	2 9/16	2 5/16	2 1/8	1 15/16	1 3/4
1/2	15 5/16	10 1/8	7 5/16	6	5	4 1/4	3 11/16	3 1/4	2 15/16	2 5/8	2 3/8	2 3/16	2
5/8	19 1/8	12 11/16	9 7/16	7 1/2	6 1/4	5 5/16	4 5/8	4 1/16	3 5/8	3 5/16	3	2 3/4	2 5/16
3/4	22 13/16	15 3/16	11 5/16	9	7 7/16	6 3/8	5 1/2	4 7/8	4 3/8	3 15/16	3 9/16	3 5/16	3 1/16
7/8	26 13/16	17 3/4	13 1/4	10 1/2	8 11/16	7 7/16	6 7/16	5 11/16	5 1/16	4 5/8	4 3/16	3 13/16	3 9/16
1	30 5/8	20 5/16	15 1/8	12	9 15/16	8 1/2	7 3/8	6 1/2	5 13/16	5 1/4	4 13/16	4 3/8	4 1/16

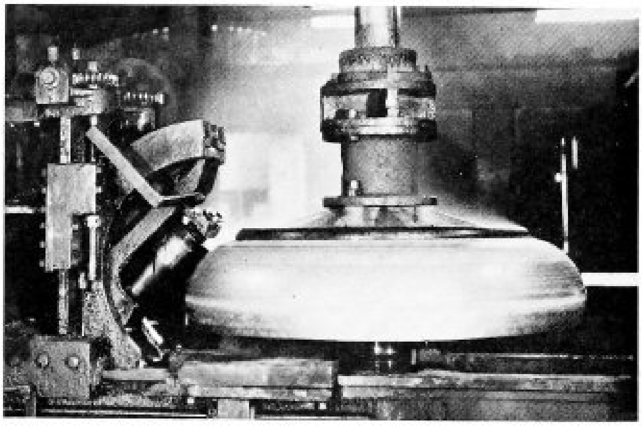
Note 1—The radii given in this table were calculated to the nearest 1/16 in.
Note 2—These recommended bending radii are not to be taken as representing the absolute limit to which wrought iron plates can be bent. The values shown are sufficiently liberal to take into account ordinary variations in material, practice, and equipment.

tributing the stretch over the entire circumference of the bent portion. Poor equipment or practice may, in some rare cases, produce satisfactory results, but ordinarily the metal will be punished unnecessarily. Even within the physical limitations of the metal, poor equipment or practice can cause failure and consequent dissatisfaction.

For these reasons it is essential that we mention the various types of equipment and methods commonly employed in bending plates.

Roll-Bending—Roll-bending is one of the most satisfactory methods to use when bending wrought-iron plates. The equipment employed permits the metal to stretch uniformly over the entire circumference of the bent portion. This, of course, is an important consideration when bending any plate metal. There are two types of roll-bending equipment in general use; namely, the pyramid roll and the initial roll. Fig. 6 shows a pyramid roll in operation bending 3/4-in. wrought-iron plates, while the sketch in Fig. 7 clearly illustrates the initial roll.

V-Block and Press—The V-block and press is commonly used in plate bending. There are a number of variations in the equipment, but the principle on which they all operate is clearly illustrated in Fig. 8. In general, this type of equipment is not as satisfactory for use in bending wrought-iron plates as some of the other types, because it has a tendency to localize or limit the stretch to a short segment of the bent portion. Obvi-



Courtesy Lukens Steel Company, Coatesville, Pa.

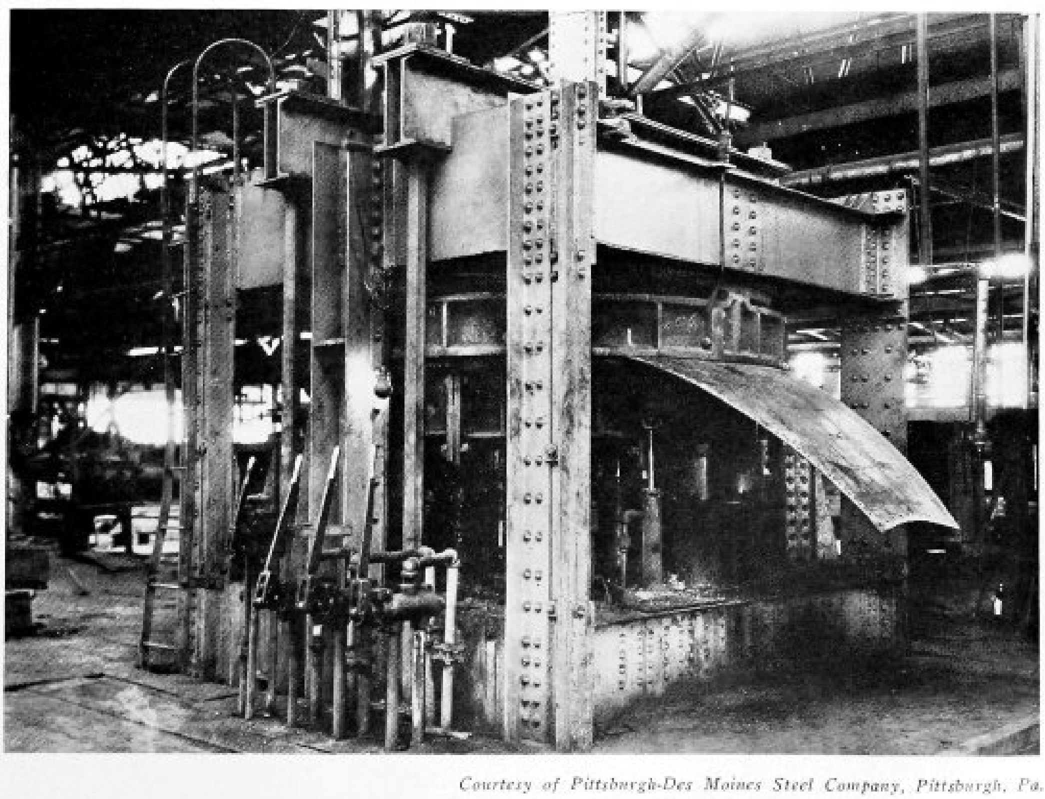
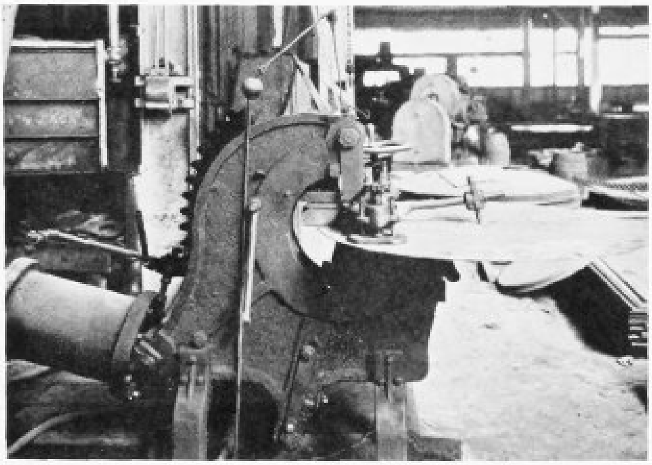


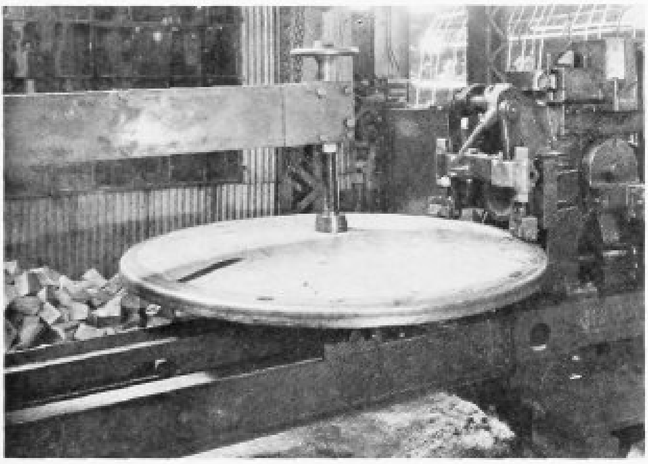
Fig. 13.—(Above) Spinning machine for forming large dished and flanged heads. Fig. 14.—(Right) Ring-type disher used for cold flanging heads up to 100 inches diameter

Courtesy of Pittsburgh-Des Moines Steel Company, Pittsburgh, Pa.



Courtesy of Pittsburgh-Des Moines Steel Company, Pittsburgh, Pa.

Fig. 15.—Sectional flanging machines used for light gage heads



Courtesy of Pittsburgh-Des Moines Steel Company, Pittsburgh, Pa.

Fig. 16.—A spinning machine for cold flanging heads 28 inches in diameter and larger

ously, if the amount of stretch exceeds the ductility of the material, fracture will occur on the outside of the bend. It should also be mentioned that in some cases the edges of the block or die are sharp enough to dig into the plate and tear the metal during the bending operation. In order to avoid this possibility, the edges of the die should be rounded sufficiently to permit the plate to move freely. Wrought-iron plates can be bent satisfactorily using a V-block and press, but the operator must be thoroughly familiar with the limitations of this type of equipment and with the characteristics of wrought iron. If a long plate is to be bent, the best results will be obtained if the complete bend is made in several passes rather than in one pass. In other words, the plate should be given an initial bend along its entire length in order to eliminate the possibility of causing a reverse kink or "buckle" in the unbent portion. The bend can then be completed in one or two passes.

Gag-Press and Bulldozer—Wrought iron plates can be bent satisfactorily using either a gag-press or a bulldozer. Ordinarily, however, the bend should be made in several passes, thereby successively decreasing the radius so that the plate is not given a reverse bend. This is a particularly important consideration where a long plate is to be bent to a short radius.

Fig. 9 shows a ¾-in. wrought-iron plate being bent on a gag-press.

There are, of course, other methods used in cold-bending plate, but the principles involved in most of them are similar to those already mentioned and therefore need not be discussed here. However, regardless of the method employed, best results will be obtained with wrought iron if the practice is modified sufficiently to take into account the physical characteristics of the metal.

Hot Bending of Wrought-Iron Plates

While a majority of the plate bending is done cold, there are certain types of bends where it is desirable to work the metal hot. Naturally, any metal can be bent more easily when hot, and wrought iron is no exception.

As in cold bending, the radius of bend is a controlling factor in hot-bending wrought-iron plates. In general the recommended bending radii shown in Table II can be decreased by approximately 50 per cent when hot bending is employed.

In hot bending the temperature at which the metal is worked is a most important factor. Wrought-iron plates should never be worked at a temperature in excess of 1,400 deg. F. Best results will be obtained if the temperature is around 1,350 deg. F. when the plate is bent.

At 1,350 deg.-1,400 deg. F. wrought-iron plates will have a dull red color in the average lighted shop. It is always advisable to eye-gage the temperature after the plate has been placed in the die by looking underneath to see the color. This procedure will give a more nearly accurate idea as to the exact temperature.

If the temperature is to be measured with an optical pyrometer, every precaution should be taken to knock the scale off the surface of the metal before the reading is taken. If this is not done, an erroneous reading will ordinarily result, because the scale will be several hundred degrees cooler than the metal.

Compound Bending

Compound bending, as the term would indicate, means that the plate metal is bent in more than one direction. It is beyond the scope of this article to give a detailed discussion of this phase of plate bending because many variables are involved. However, there are two methods by which wrought-iron plates can be bent satisfactorily.

Wrought iron plates can easily be formed either hot or cold by practically any of the commonly used methods provided, of course, that the characteristics of the material are taken into account. One of the most important considerations is to employ a method that will permit the stretch in the metal to be as nearly uniform as possible. Localized stretching should always be avoided.

The equipment shown in Fig. 10 is particularly adaptable for use in bending wrought-iron plates, since it permits the metal to stretch uniformly. In many cases when compound bends must be made, it is undesirable from the economic standpoint to have dies built or cast. Under such conditions other means of bending the plate must be employed.

Figs. 11 and 12 give two views of the same wrought-iron plate being formed into a knuckle plate for the hull of a tunnel boat built in 1934 for the U. S. Engineers. The plate was first bent with the bend line lengthwise of the plate, as shown in Fig. 11. It was then necessary to bend it in the other direction, that is, with the bend line crosswise of the plate. In order to do this the plate was anchored as shown in Fig. 12 and the areas indicated by the chalk marks were heated. When the load was applied, the metal in the heated areas upset, thus allowing the bend to be made with a minimum of stretch on the outer surface of the bent portion.

Flanged and Dished Heads for Tanks

Special wrought-iron plate stock is produced for forming flanged and dished heads. With this special head stock it is possible to produce heads in accordance with the A. S. M. E. requirements, which state that the knuckle radius shall be not less than three times the plate thickness, or 6 per cent of the diameter of the head. Wherever possible, the largest allowable radius should be used.

Flanged and dished heads are formed by either spinning or pressing, depending upon the size. The metal is worked either hot or cold. Large heads made of heavy-gage metal are formed hot on a spinning machine. Fig. 13 shows a large spinning machine used for hot dishing and flanging circles up to 195 in. in diameter.

When hot-forming large dished and flanged heads from wrought-iron plates, the best results will be obtained if the metal is worked at a temperature of 1,350 deg.-1,400 deg. F. At these temperatures, however, the metal must be worked rapidly in order to complete the operation before the material cools.

Peripheral speed is an important consideration in hot-flanging large wrought-iron heads on a spinning machine. It has been found that a speed of about 800 ft. per minute gives good results. This is a somewhat slower speed than that ordinarily used for steel, but, generally speaking, wrought iron must be worked more slowly than steel if any severe forming operation is to be entirely satisfactory.

Cold dishing and flanging of wrought-iron heads can be easily accomplished if ordinary precautions are taken. Figs. 14, 15, 16, and 17 show types of equipment that can be used for cold dishing and flanging wrought-iron heads.

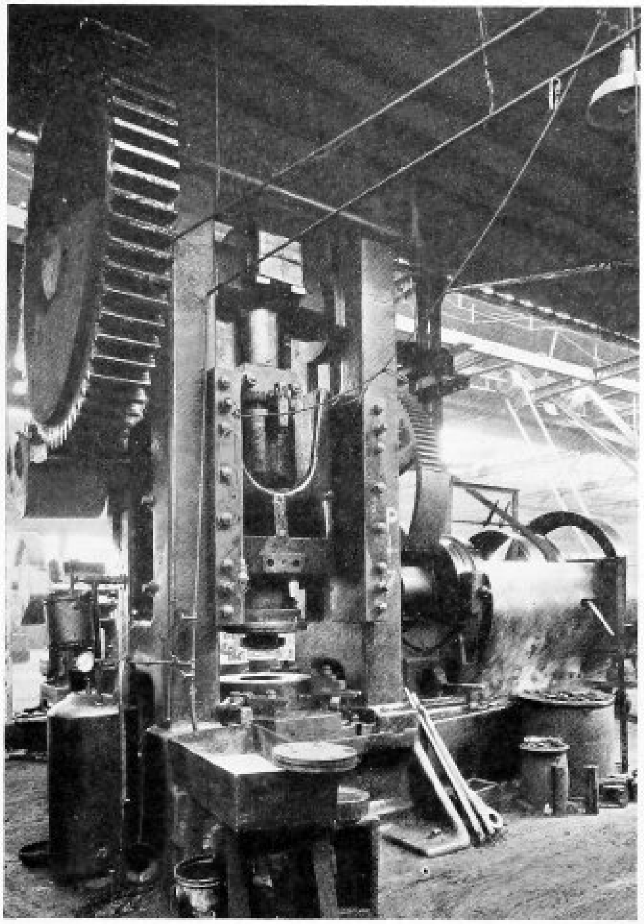
De-Scaling Wrought-Iron Plates

For some applications it is necessary to remove the mill scale from plate metal in order to provide a smooth surface for painting or other purposes. There are several different ways of removing scale, but acid pickling and blasting are the most commonly used.

The scale formed on wrought-iron plates during the rolling operations adheres tightly to the surface of the metal. In the majority of services for which wrought-iron plates are used, it would be desirable to leave the scale in place.

Pickling—When removing scale from wrought-iron plates by means of acid pickling, the pickling bath should be maintained in an active condition with an acid concentration of at least 5 to 6 per cent. The bath should be maintained at a temperature of not less than 120 deg. F. Under these conditions the scale will be completely removed in a short time without undue injury to the underlying metal. In some cases it may be desirable to use an inhibitor in the acid bath to produce a smoother finished surface. However, if the scale is removed in order that the surface may be given a metallic coating, such as galvanizing, the use of an inhibitor is not advisable. When wrought iron is pickled, the acid attacks the metal, but not the slag, thereby making the resultant surface comparatively rough. Obviously a rough surface offers a better anchorage for a coating than a smooth one, and for that reason wrought iron will take on a heavier and more adherent coating than will other metals.

Sand and Metal Blasting—Sand blasting has been used for years to remove scale from metal surfaces. Within the past few years, however, another method of blasting has been developed in which hardened metal particles are employed in place of sand. Generally speaking, blasting with metal particles has a more severe effect on the plate material than does sand. This is particularly true of



Courtesy of Wm. B. Scaife & Sons Co., Oakmont, Pa.

Fig. 17.—Press used for cold dishing and flanging small tank heads

wrought iron because it is soft and has a fibrous structure. Where it is necessary to remove the scale from wrought-iron plate by blasting, we recommend that sand blasting be used. This method can be relied upon to remove completely the scale, and it does not seriously affect the metal surface.

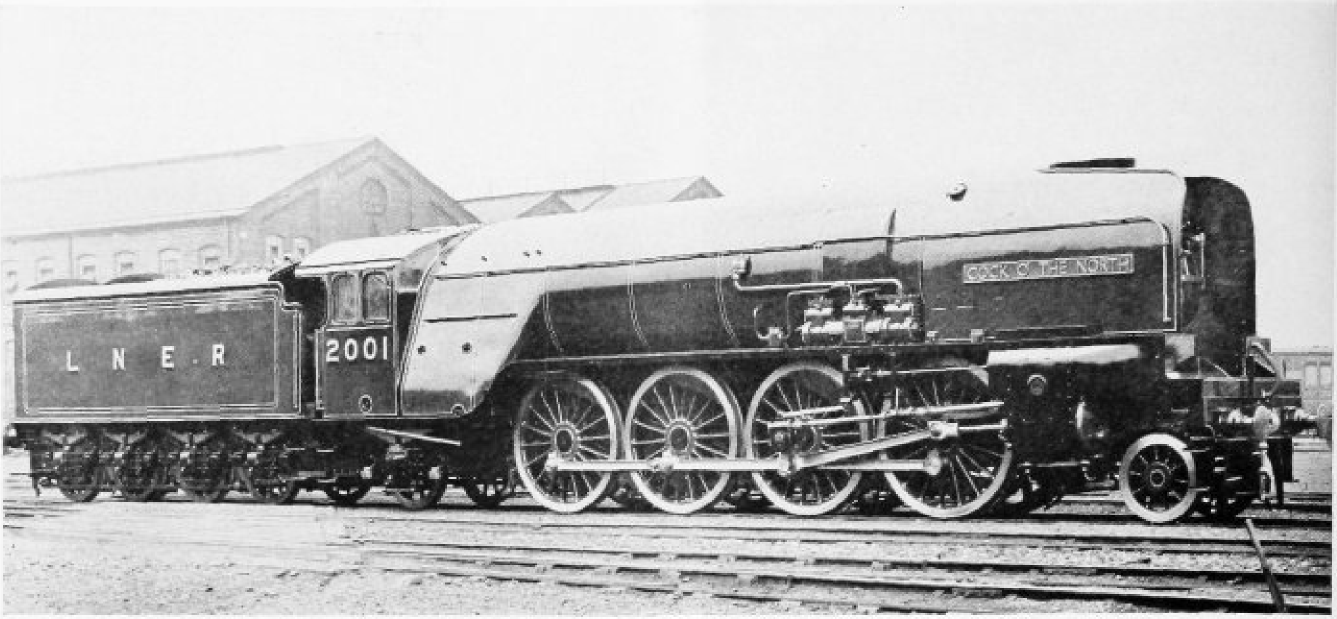
Mechanical Associations

(Continued from page 85)

"You are probably aware that, because of the necessity for economy in railroad operation, the number of conventions being held by the various Divisions of our Association have been limited."

Apparently the Association of American Railroads has washed its hands of all responsibility for these organizations. Obviously the conventions are entirely off for the spring of this year. It would seem that some group somewhere, preferably the Mechanical Division, should step in and take the leadership in deciding the best course to follow. Should these associations be revived and be encouraged to resume their former activities and programs? How have changed conditions affected their importance and value? Will it be advantageous to combine some of them? Have some of them outgrown their usefulness?

There can be no question of the value of these organizations in the scheme of railroad operation in the future. Some means must be developed by their officers working in the closest harmony to make possible their early revival.



New British locomotive for passenger service

Boiler of the 2-8-2 Type Express Locomotive for L. & N. E. R.

By E. C. Poultney

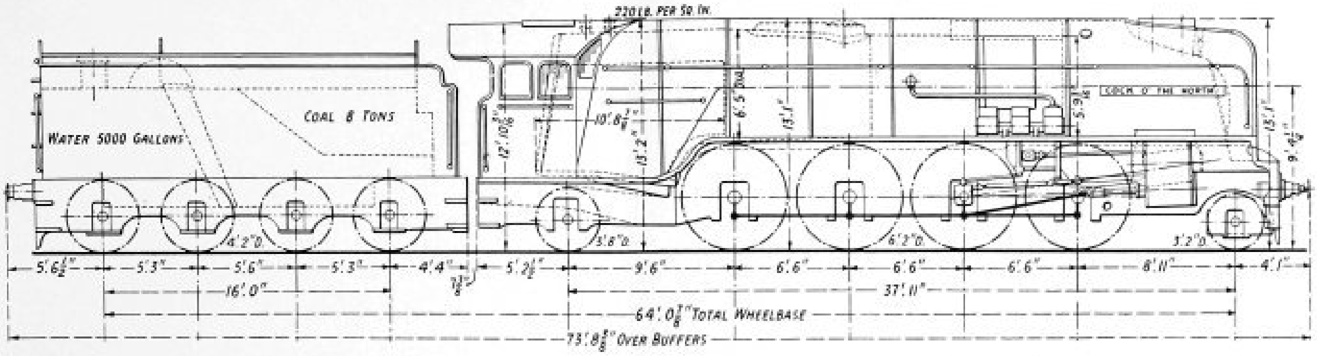
The London & North Eastern Railway has recently placed in service the first eight-coupled passenger locomotive to be used in British railway service. It was designed by H. N. Gresley, chief mechanical engineer, L. & N. E. R., for the handling of express passenger trains over the 130-mile territory between Edinburgh (Waverly) and Aberdeen. Heavy grades are encountered in this district and the Pacific type passenger locomotives which are used in the same territory are required to haul trains of 540 (short) tons northbound from Edinburgh to Aberdeen, and 470 tons in the opposite direction. Since some of the more important express trains involve train loads of as much as 615 tons, exclusive of engine and tender, it has become necessary to provide locomotives of greater power in order to handle this traffic.

All important express trains on the L. & N. E. R. between London and Edinburgh and thence on to Aberdeen are handled by three-cylinder Pacific type locomotives which, when first built in 1922, had a rated tractive force of 29,835 pounds: cylinders, 20-inches by 26-inches, with 80-inch driving wheels, and 180-pounds boiler pressure. Later locomotives were provided with boilers carrying 220-pound pressure and equipped with 43-element superheaters instead of the 32-element type originally used. These locomotives developed a tractive force of 36,465 pounds.

The new locomotive has a rated tractive force of 43,462 pounds, which is greater than any other express passenger locomotive in the British Isles. In order that sufficient adhesion might be provided with a mean axle loading of 44,800 pounds, eight-coupled wheels became necessary. This locomotive, therefore, has the further distinction of being the first eight-coupled express locomotive in British railway service. The weight on drivers is 180,544 pounds, which is 73 percent of the total engine weight of 246,960 pounds, giving a factor of adhesion of 4.15. Because of limited clearances prevailing on British railways, the overall width is only 9 feet and the maximum height 13 feet 1 inch.

The boiler carries 220-pounds per square inch working pressure. The barrel portion is in two sections, that next to the firebox being tapered and having a maximum diameter of 77 inches, while the front course is cylindrical and has a diameter of 69 5/16 inches at the smokebox flue sheet. There are 121 2¼-inch tubes and 43 5¼-inch flues for the type A superheater, which is of the latest pattern with Sinuflo elements having an outside diameter of 1¼ inches, the elements being expanded into the header casting.

The dome, which contains the throttle valve, is of a novel form. Actually, the steam supply is taken from the boiler outside of the dome and enters it through a series of 18 slots in the top of the tapered section of the boiler barrel, which is reinforced at this point by a steel plate in which a corresponding number of slots are also cut and which is riveted to the inside of the barrel sheet. The ob-



L. & N. E. R. three-cylinder eight-coupled express locomotive—Diagram giving leading dimensions

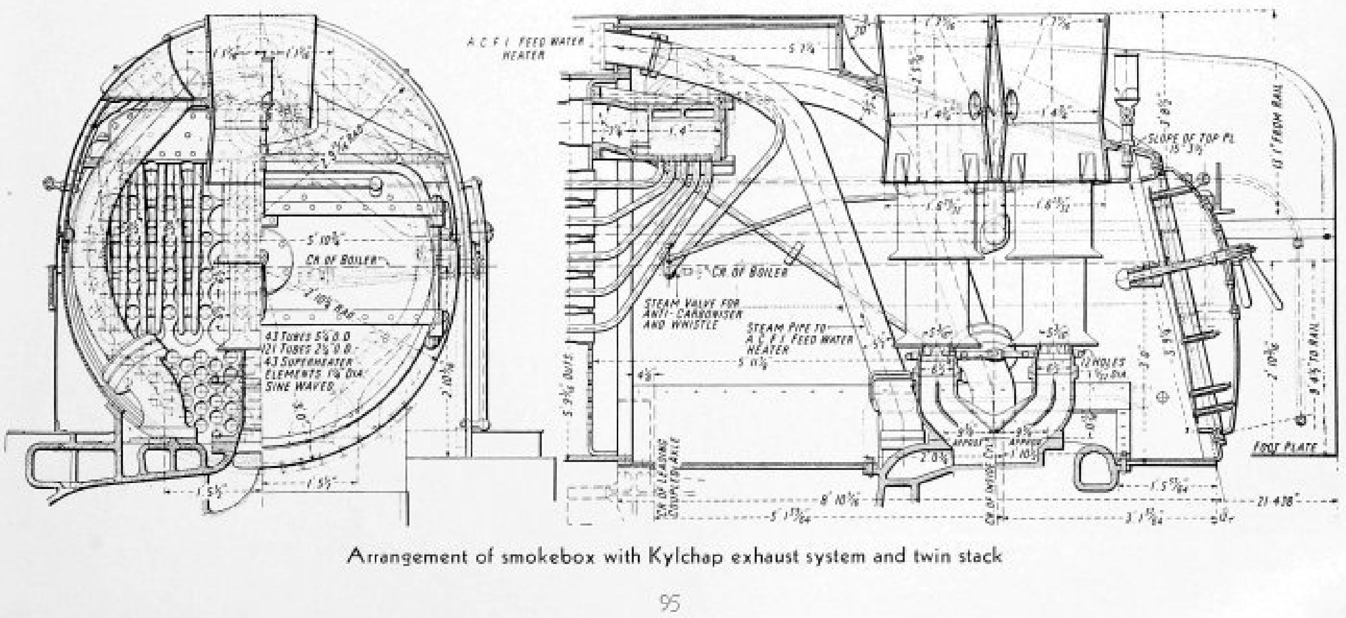
Principal Dimensions and Weights of the L. & N. E. R. Three Cylinder 2-8-2 Type Express Locomotive

Road	London & North Eastern
Service	Express passenger
Rated max. tractive force	43,462 lb. (at 85 per cent boiler pressure)
Weight on drivers ÷ max. tractive force	4.15
Cylinders, dia. and stroke	3-21 in. by 26 in.
Valve gear, type	Rotary cam
Weights in working order:	
On drivers	180,544 lb.
On front truck	25,760 lb.
On trailing truck	40,656 lb.
Total engine	246,960 lb.
Tender (loaded)	123,872 lb.
Total engine and tender	370,832 lb.
Wheels: diameter:	
Coupled	74 in.
Front truck	38 in.
Trailing truck	44 in.
Wheel bases:	
Driving	19 ft. 6 in.
Total engine	37 ft. 11 in.
Boiler:	
Steam pressure	220 lb.
Tubes, number and diameter	121—2¼ in.
Flues, number and diameter	43—5¼ in.
Length between tube sheets	19 ft. 0 in.
Grate area	50 sq. ft.
Heating surfaces	
Firebox	237 sq. ft.
Tubes and flues	2,477 sq. ft.
Total evaporative	2,714 sq. ft.
Superheating surface	635.5 sq. ft.
Comb. evap. and superheat	3,349.5 sq. ft.
Tender:	
Water capacity	5,000 Imp. gal.
Coal capacity	17,920 lb.

ject of the steam-collector arrangement is to deliver steam as dry as possible.

The grate area is 50 square feet; the firebox heating surface, 237 square feet; the total evaporative heating surface, 2714 square feet, and the superheating surface, 635.5 square feet. The length between the tube sheets is 19 feet. The inside firebox is of copper, as is usual in British practice. The copper plates comprising the wrapper, back head and throat sheet are 9/16 inch thick, and the dished tube sheet is 1¼ inches thick. The firebox at the mud ring inside is 86 inches long by 83¾ inches wide. The safety valves are of the pop type, two in number, and 3½ inches in diameter. Boiler feed is provided by an A. C. F. I. feed-water heater, the pump portion being mounted on the right-hand side, and the mixing chamber fitted in saddle form on the top of the boiler barrel at the front end. An injector is fitted for use when required. Alfol insulation has been used for covering the boilers.

Much care and consideration have been given to the design of the front end, the outside form of which has been developed with the aid of wind-tunnel experiments to obtain an effective smoke lifter by the use of wing-plates. This together with the smooth finish given to the boiler jacket, which is specially shaped and finished off flush with the top of the pointed front given to the cab and without dome projection, provides a form of streamlining which should reduce air resistance at high speeds. The smokebox is equipped with a double stack and exhaust pipe. Each exhaust pipe is 6½ inches in diameter with 5 3/16-inch nozzles fitted with four adjustable, radial, wedge-shaped projections for splitting the exhaust jet. Above each exhaust nozzle is a bell-mouthed petticoat pipe, each containing four tubes shaped into a form something resembling a four-leaf clover. Above this is a sec-



Arrangement of smokebox with Kylchap exhaust system and twin stack ond petticoat pipe without division plates. The small diameter of each stack is 16¾ inches. This double exhaust arrangement, known as "Kylchap," or "K.C.," was developed by Mons. Chapelon on the Paris-Orleans railway and has since been adopted by a number of European roads. It is reported that the design has provided an excellent draft with unusually low back pressure.

The eight-wheel tender has a water capacity of 5000 Imp. (6000 U. S.) gallons, and there is space for eight long or nine short tons of coal. It runs on eight 50-inch diameter wheels, not in trucks. The wheel base is 16 feet and rigid, except for the lateral play allowed in the boxes.

This locomotive, of which the principal dimensions appear in the accompanying table, was built at the company's Doncaster shops.

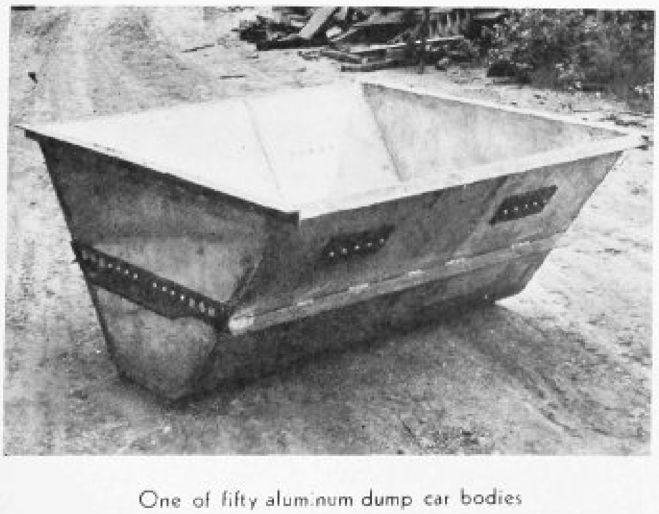
Arc Welding Aluminum Dump Car Bodies

One of the most interesting of recent applications of the welding of aluminum with the electric arc is the construction of 50 dump car bodies for the Freeport Sulphur Company, Freeport, Tex. These units were built entirely of arc welded aluminum by the Wyatt Metal and Boiler Company, Houston, Tex., and will be used in sulphur purification work.

Each of these dump car bodies is 5 feet long, 2 feet 6 inches deep and 4 feet 8 inches wide at the top, tapering to 7 inches width at the bottom. Aluminum is used throughout and permits extremely light construction, each scoop weighing only 310 pounds complete.

In building the scoop, two pieces of ¼-inch aluminum sheet are cut to the desired size and shape for the two ends. These ends are then provided with the necessary rigidity by welding an angle (also of aluminum) along the upper edge of each end. These angles are longer than the ends are wide and extend out approximately 3 inches at each end.

The next step is the building of the sides of the scoop. This is done by cutting two lengths from ¼-inch aluminum sheet—the length being equal to the distance from the top edge of one side of the scoop down around the bottom and up the other side to its top edge. These two pieces of sheet are not of equal width, one being 3⅓ feet wide, the other 1⅔ feet. These sheets are then butt welded together their full length. Four aluminum angles are then welded to the sides, one along each of the edges, and one across each of the sides approximately halfway between the top and bottom of the scoop. The latter angles are tack welded in place.



One of fifty aluminum dump car bodies

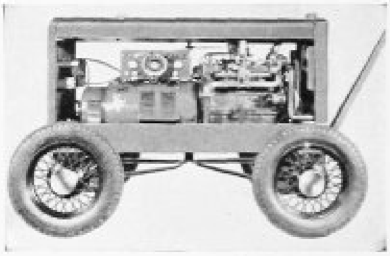
The next step is to place the two ends the proper distance apart and fit the sides to them. The whole unit is then placed in a jig made especially for the purpose and stood up on one end so that the welding can be done continuously in the flat position. After one end is welded, the unit is reversed and the other end welded. Construction is then completed by welding the extending angles together at the upper four corners of the scoops.

The arc welded construction of these dump car bodies provides high tensile strength, due to the very dense, non-porous quality of the weld metal.

The welding was done with equipment and "Aluminweld" electrodes supplied by The Lincoln Electric Company, Cleveland.

Simplified Arc Welder

Several unusual features are incorporated in the new Model HF, factory-built, gasoline-engine-driven Simplified arc welders announced by The Hobart Brothers Company, Troy, O. More powerful engines with modern improvements, with six or eight cylinders insuring a smooth flow of power, and a number of convenience features new to the welding industry are pointed out.



Hobart arc welder

Startix equipment with automatic choke and downdraft carburetor, is an outstanding advantage never before available with arc welding equipment. This eliminates the delay, fatigue and danger incident to hand cranking. The Startix goes into operation as soon as the ignition switch is turned on and automatically cuts out the instant the engine starts. The automatic choke, thermostatically controlled, insures quick starting without danger of flooding, in all kinds of weather.

Calibrated ignition with vacuum controlled distributor insures maximum economy with freedom from "ping" when using ordinary commercial gasoline. A special generator supplies ample current to keep the storage battery charged, even when it is used for lights on the job. Air, oil and gas filters are standard equipment.

The 200 and 300-ampere sizes are equipped with a 6-cylinder engine, while the 400-ampere size is the first arc welder to be equipped with a heavy duty, 8-cylinder industrial engine. Variable speed adjustment makes it possible for the operator to select the most suitable and economical engine speed for each job, at any point from 1000 to 1800 revolutions per minute, full rated capacity being available at 1500 revolutions per minute. All three sizes embody the special features heretofore mentioned.

Development of new corrosion resisting

ALLOY STEELS*

In both the railroad field and the contract plate fabricating field for cars, tanks, and vessels of many varieties, the demand has become increasingly great for steel having greater strengths than low or intermediate carbon open hearth steel, combined with satisfactory forming qualities; increased resistance to corrosion, and at a price which would not prohibit its wide application.

At the laboratories of the United States Steel Corporation, some months ago, an analysis of different steels in production or in process of development indicated that one possessed outstanding qualities. This was a chromium-copper-silicon steel of low carbon content, which has since been produced commercially under the name of Cor-Ten. One of the unique advantages of this steel is the fact that the excellent physical properties are derived from the alloying elements and it is essentially a non-air-hardening steel. Even rapid cooling from any temperature normally used in fabricating does not produce appreciable hardening. Cold working, however, will develop increased hardness with correspondingly higher yield point and ultimate strength.

The resistance to corrosion of this material, under ordinary conditions, was found to be considerably greater than any other available steels with the exception of the more costly high chromium steels.

To afford a selection of material of high tensile strength, with a smaller price differential over ordinary open hearth steel, it was decided to make available also, in forms suitable for marine use, two steels which had previously been used in forgings and rolled sections, namely, a medium manganese steel, now produced under the name of Man-Ten and a structural silicon steel, which has been given the name Sil-Ten. These two steels are available with a small percentage of copper, in which case the resistance to atmospheric corrosion is on a par with copper bearing open hearth steel, but lower than that of Cor-Ten.

The chemical compositions of Cor-Ten, Man-Ten and Sil-Ten are shown in Table 1, and the physical properties in Table 2, for sheets and strip, and in Table 3, for shapes, plates and bars.

In rivet shearing tests made on ⅝-inch diameter hot-driven rivets in double shear Cor-Ten developed an ultimate average shearing value of 81,500 pounds per square inch. The ultimate tensile strength of the rods from which the rivets were made was 80,900 pounds per square inch. Man-Ten rivets developed 89,800 pounds per square inch average ultimate shearing strength, the tensile strength of the rods being 97,990 pounds per square inch. The bearing values per square inch in both cases were more than twice the shearing values.

Atmospheric corrosion tests of steels were conducted by exposing cleaned and weighed samples, principally sheets, to the action of weather conditions at several typical locations. The amount of corrosion of the different materials was determined by measuring the loss of weight of samples exposed under strictly comparable conditions, which has proved to be the most accurate method. In all the corrosion tests care was taken to compare only those samples which were initially exposed at the same time and for the same period of time at the same location.

In the development of Cor-Ten and other steels over a period of six years, more than 30,000 samples, comprising about 850 materials in 145 different laboratory and field tests, have been studied.

Representative samples of Cor-Ten and other steels exposed for more than three years indicate that this steel under the conditions of the test has a resistance to atmospheric corrosion four to six times as great as good plain steel, depending on the quality of the plain steel with which it is compared.

The slow, rapidly decreasing rate of corrosion of Cor-

Table 1.—Chemical Properties of Low Carbon Steel and of Low Alloy High Tensile Steels

Chemical Composition	Regular Open Hearth	Cor-Ten	Man-Ten	Sil-Ten
Carbon, percent max.	0.10	0.10	0.35	0.40
Manganese, percent	0.30–0.50	0.10–0.30	1.25–1.70	0.70–0.90
Phosphorus, percent	0.04 max.	0.10–0.20	0.04 max.	0.04 max.
Sulphur, percent max.	0.05	0.05	0.05	0.05
Silicon, percent	0.10	0.50–1.00	0.15 min.	0.20–0.30
Copper, percent	0.20*	0.30–0.50	0.20*	0.20*
Chromium, percent	....	0.50–1.50	....	....
Corrosion resistance (atmospheric, comparative)	1†	4 to 6	1†	1†

* If specified.
† Or 2 to 3 with copper.

Table 2.—Physical Properties of Low Carbon Steel and of Low Alloy High Tensile Steels in Sheets and Strip

Physical Properties	Regular Open Hearth	Cor-Ten	Man-Ten
Yield point, lbs. per sq. in.	25,000 min. to 35,000 min.	50,000 min. to 60,000 min.	55,000 min. to 65,000 min.
Tensile strength, lbs. per sq. in.	35,000 min. to 50,000 min.	65,000 min. to 75,000 min.	80,000 min. to 90,000 min.
Elongation, percent in 2 in.	34 to 25	27 to 22	25 to 20

Note.—Ranges of physical properties are minima and cover possible heat treatments suitable for sheets.

Table 3.—Physical Properties of Low Carbon Steel and of Low Alloy High Tensile Steels in Plates, Shapes and Bars

Physical Properties	Regular Open Hearth	Cor-Ten	Man-Ten	Sil-Ten
Yield point, lbs. per sq. in.	0.5 × ten. str.	50,000 min.	55,000 min.	45,000 min.
Tensile strength, lbs. per sq. in.	48/58,000 or 50/65,000	70,000 min.	85,000 min.	80/95,000
Elongation, percent in 2 in.	27 or 25	27	23	24
Endurance limit, lbs. per sq. in. (normalized)	25,000	45,000	40,000	
Modulus of elasticity, lbs. per sq. in.	$28. - 30. \times 10^6$	$28. - 30. \times 10^6$	$28. - 30. \times 10^6$	
Izod impact, ft. lbs. (normalized)	30	60	40	
Coefficient of expansion, per degree F., 70°-200° F.	6.4×10^{-6}	6.7×10^{-6}	6.3×10^{-6}	

* Abstract of a paper presented at the annual meeting of the American Society of Mechanical Engineers, by G. N. Schramm, corrosion research laboratory, American Sheet and Tin Plate Company, Vandergrift, Pa.; E. S. Taylerson, manager, research laboratory, American Sheet and Tin Plate Company, Pittsburgh, Pa., and Albert F. Stuebing, railroad mechanical engineer, commercial office, United States Steel Corporation, New York, N. Y.

Ten in the atmosphere results in a smooth evenly corroded surface. The coating, or rust film, that forms is harder and much more adherent than that which forms on ordinary steels. Severe abrasive action is necessary to remove this dense coating, and after it has been removed the base is found to have been corroded uniformly.

In proposing the application of these special steels, one of the governing considerations was their adaptability for forming cold or hot. The physical properties of all three materials are such that these steels can be bent or pressed cold with only moderate and reasonable changes from the common practice in using low carbon steel. The technique of forming them is slightly changed from that of ordinary carbon steel, consisting principally of making provision for more liberal radius of bend, slightly increased die clearance, and more spring-back of the bend. These features produce no particular difficulties after the shop forces understand how the steels should be worked.

It is natural to expect that these steels, having considerably higher physical properties, even though they retain good ductility, would be stiffer and, therefore, more difficult to bend or press cold. Both Cor-Ten and Man-Ten, however, have been satisfactorily formed as ordinarily required. It has been found that for cold flanging to an angle of 90 degrees the radius of the bend with sheets of either of these steels should be at least twice the thickness of the material to insure good results. If plates 1/4 inch or more in thickness are to be pressed in the "as rolled" condition, either with or across the direction of rolling, the diameter of the fillet should be three times the thickness of the section. Experience has shown that normalized light plates of Cor-Ten pressed cold do not spring back any more than ordinary open hearth pressed in the "as rolled" condition.

As regards hot-forming operations Cor-Ten may be classed with low carbon steel because it is essentially a non-air-hardening steel. Man-Ten and Sil-Ten, however, have higher carbon content, therefore, normal care must be taken to insure that shop practices are not detrimental to these materials. In hot pressing Cor-Ten the most satisfactory results have been obtained at temperatures of 1500 degrees to 1600 degrees F. Man-Ten should be pressed at 1400 degrees to 1500 degrees F.

Test pieces cut from the webs of diaphragms, both hot and cold pressed, show a moderate increase in the yield point of the Cor-Ten material, with practically no change in ultimate strength and elongation as compared with test pieces taken from the same sheets before pressing.

Cor-Ten rivets should be driven at temperatures between 1800 degrees and 1900 degrees F. At lower temperatures the material is stiffer and more difficult to drive than ordinary open hearth steel.

Cor-Ten steel can be welded satisfactorily by using any one of several coated carbon steel electrodes. The strength of such welds, properly made, is substantially equal to that of the parent metal, and ductility is ample. There is no evidence of electrolytic action or accelerated corrosion at the junction of the deposited metal and the parent metal.

If it is desired to have the deposited metal of approximately the same composition as the Cor-Ten, this can be accomplished by using electrodes of special composition, which are now available. The results of tests of welds made with such electrodes and also with coated carbon steel electrodes are shown in Table 4.

Tests have been made to determine the power consumption and time required for punching, drilling and reaming Cor-Ten and Man-Ten steels in comparison with ordinary open hearth steel. Plates of equal thickness were used in these tests.

The punching tests indicated that the costs for Cor-Ten and Man-Ten were practically the same as for ordinary open hearth steel, the only possible variation being an increase of not over 25 percent in power consumption and a similar increase in tool maintenance, with no change in time or labor cost.

Tests made by drilling 5/8-inch holes with high speed drills in plates 1/2 inch thick indicate that the actual drilling speed for Man-Ten can be the same as for ordinary open hearth steel, but for Cor-Ten the rate should be reduced about one-third from the maximum permissible with open hearth steel, to insure satisfactory life of drills. In countersinking with manual feed there was no appreciable difference in time or power consumption between ordinary open hearth steel and Cor-Ten, but with Man-Ten the time was 20 percent less.

Reaming tests were conducted on 1/4-inch plates of the same steels and consisted of enlarging punched holes from 5/8 inch to 3/4 inch and from 3/4 inch to 13/16 inch with a portable electric motor driven reamer. The time required was the same for all three steels but the power consumption when reaming Cor-Ten and Man-Ten was approximately 30 percent less than when reaming the open hearth steel. This result was contrary to expectation and was therefore carefully checked by a second series of tests, which confirmed the original tests.

A probable explanation of the lower power consumption of the high tensile steels was found in the action of the cutters. When reaming Cor-Ten and Man-Ten, the reamers cut a clean chip whereas the softer open hearth steel seemed to deform and cause a frictional drag on the cutter.

The reaming tests demonstrated that Cor-Ten and Man-Ten can be reamed with no increase in labor cost as compared with open hearth steel and with lower power consumption. The reamers used in the Man-Ten steel showed slight discoloration at the point, and it was thought that in production, reamers used in this material might require redressing at slightly shorter intervals.

TABLE 4.—TESTS ON WELDING OF COR-TEN PLATES

Thickness of Cor-Ten plates, 3/8 inch.
Spacing of plates for butt welding, 1/8 inch apart.
Welding machine voltage, 35; current, 180 amperes; polarity reversed.
Size of welding rod, 3/16 inch diameter.
Tensile properties of samples, comparative tests on 3/8 inch plates—

	Ultimate	Elong. in 2 inches Percent	Elong. in 1 inch Percent
Cor-Ten plates, before welding.	70,700	33.0	...
Plates welded with Cor-Ten-Weld rod	74,200	17.5	23.3
Plates welded with regular carbon steel welding rod	71,700	19.7	26.8

Similar tests made on 1/4-inch Cor-Ten plates, with original ultimate strength 79,400 pounds per square inch and 25.5 percent elongation, showed for the Cor-Ten-Weld 76,400 ultimate, 15.3 percent elongation in 2 inches, and for the regular carbon steel weld 71,300 ultimate, 12.5 percent elongation. The elongation in 1 inch was 22 percent in both cases.

Nick-break tests showed a fine crystalline fracture, free from porosity.

Brinell hardness tests on specimens of 3/8 Cor-Ten plates, welded with Cor-Ten-Weld rod, gave the following results:

(a) At the weld—135, 135, 135.
(b) Plate adjacent to weld—143, 143, 140.
(c) Plate, as produced—143, 143, 140.

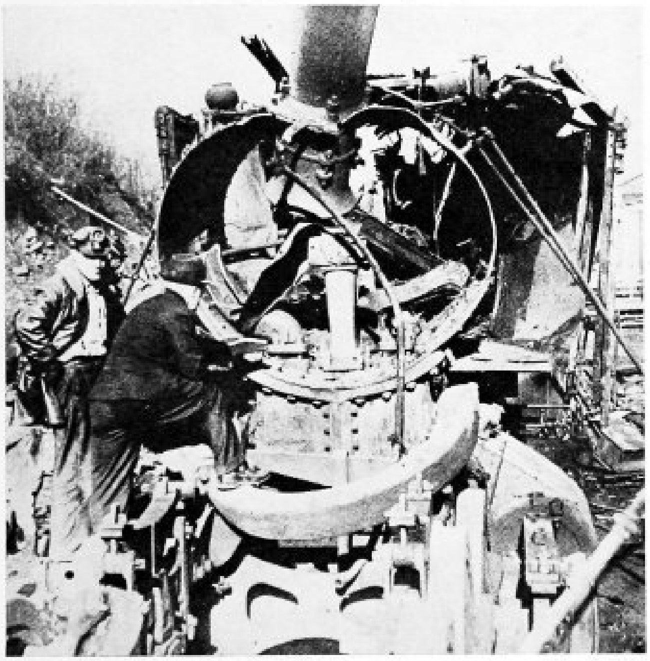
Seattle Office of Republic Steel

Effective April 1, the Seattle, Wash., District Sales Office of Republic Steel Corporation, will be removed to the White-Henry-Stuart Building, according to N. J. Clarke, vice-president in charge of sales for Republic.

C. D. Winter continues in charge of the office as district sales manager, assisted by his present staff to which will be added Archie Rider, recently transferred from the Youngstown offices.

Major pressure vessel and

BOILER EXPLOSIONS*



Disastrous locomotive boiler explosion

Sixteen men lost their lives and forty-two were injured, some of them seriously, in the early morning of December 27, 1934, when a railroad locomotive boiler exploded, hurtling in the air and crashing down on a wooden passenger coach.

The accident occurred at McDunn, near Powellton, West Virginia, as about three hundred workmen were being taken from their homes to a mine. The killed and injured were in the first car of a four-car train.

Failure, which was attributed to low water and overheating, evidently occurred in the crown sheet, the released steam tearing off the engine's smokebox cover and hurling it into the first car, which was coupled to the front end of the locomotive. Simultaneously the boiler was blown up into the air, and came down in the center of the leading coach, tearing away the top and one side. The cab was hurled through the roof of a nearby house.

Failure of Concealed Head Proves Costly

Bristol, on the border between Virginia and Tennessee, was plunged into darkness at 7:45 P. M. Sunday, November 25, 1934, when a violent boiler explosion at the city gas plant tore down power lines. The force of the explosion was so terrific that the concussion shook buildings and caused excitement throughout the city. It was almost an hour before emergency repairs put the lighting system back into service. At the gas plant the boiler house was completely demolished and the city fire department was obliged to fight a blaze which for a time threatened two large gas holders.

The explosion was attributed to the failure of the concealed head of the lower drum in a 250-horsepower bent-tube type boiler. The blank head is reported to have plowed through the setting of a second boiler, bending the shell, smashing through the tube banks and passing out through the setting on the other side.

Those near the scene of the accident reported that the exploding boiler turned a complete somersault before it came to rest. Flying debris demolished a switchboard, two 300-kilowatt transformers, and the condensers for two 300-kilowatt turbines, but fortunately missed the turbines. Although one of the large gas holders was bombarded from top to bottom with flying bricks, it was not punctured.

The roof of the power house was blown off, two sides of the building were torn away, and the plant's stacks were knocked down.

At the time of the explosion a fireman was cleaning the fire. He was blown across the boiler room and lived only a short time after the accident. Another workman sustained minor injuries.

Six Die Following Explosion

Six men lost their lives when a second-hand horizontal tubular boiler exploded at the scene of hardwood lumber cutting operations near Baggs Bay, 15 miles south of Claxton, Georgia, on December 12, 1934. An investigation revealed that the initial rupture probably occurred in the rear tube sheet around the manhole opening. The sheet had become thin at that spot as the result of corrosion from a leaking manhole gasket. The boiler was of the horizontal tubular type, 48 inches diameter and 12 feet long. Its two courses had double lap riveted longitudinal seams.

Brooklyn Kier Accident

When the cover of a cloth treating kier blew off on September 27, 1934, at a Brooklyn dry goods establishment, the explosion draped streamers of cloth on nearby city buildings in a confused array and injured six persons who resided in the neighborhood. For the thirty girl employes it was fortunate that the accident occurred during their lunch hour. Otherwise, some of them would undoubtedly have been injured.

The kier was 6 feet in diameter and 8 feet deep, and was one of two which were used for boiling the dirt and cotton residue out of newly woven goods, about a ton of cloth being put into each kier and boiled for two days.

In the bottom of the vessel was a grating which prevented the material from resting on the lower head. A circulating pipe went up through the center of the tank, carrying steam and water upward in such a way that the action somewhat resembled that in a coffee percolator. Normal operating pressure was not in excess of 10 pounds and there was a relief valve to prevent overpressure. Besides the relief valve there was a pressure regulator in the line from the boiler and this was set to hold the

* Published through the courtesy of *The Locomotive*, Hartford Steam Boiler Inspection and Insurance Company.

pressure in the kier at 10 pounds. The boiler furnished steam at about 40 pounds.

The accident blew the 1000-pound cover over an adjacent one-story building, the heavy metal disk coming to rest in a street about 80 feet away. The contents, which happened to be about 30,000 yards of cheesecloth, were hurled in the opposite direction and strewn over nearby buildings, draping them in fantastic fashion much to the interest of the residents of the thickly settled neighborhood. The brick walls and roof of the building housing the kiers were wrecked, and bricks and large stones, which were hurled onto the roofs of four adjacent houses, resulted in some damage to them and in minor injuries to their occupants.

The train of events which led to the explosion probably never will be known accurately, but presumably the circulating pipe became clogged, thereby permitting pressure to accumulate in the lower part of the vessel to such an extent that the entire contents were moved upward toward the top of the kier, eventually closing the relief valve outlet and the outlet to the steam regulator. This would have caused the regulating device to remain in full open position and admit boiler pressure to the vessel, which was more than the head of the kier could stand.

Drum Explosion Levels Boiler House

The top rear drum of a bent-tube type boiler operating at 89 pounds pressure exploded on October 22, 1934, at a southern cooperage works, causing property damage and minor injuries to three men. Failure started in the double-riveted lap-joint of the longitudinal seam. The tear ran through the row of rivets next to the calking edge for about 6 feet, then through the solid plate to the heads at each end and finally into the heads themselves. So severe was the blast that it demolished the setting of an adjacent boiler, blew down the sheet-iron boiler shed, and brought the steel smokestack crashing down.

The night watchman who was passing through the boiler room was burned and cut, a negro fireman was burned and a stranger in the yard was struck by a piece of concrete. The engineer, who had been working on top of the boiler only a short time prior to the explosion, said more persons probably would have been injured had not the accident occurred between shifts.

Preliminary findings indicate that this accident may have been the result of caustic embrittlement and an investigation is being made to determine more exactly how the metal became weakened.

Revisions and Addenda to the A. S. M. E. Boiler Code

It is the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the Rules and its Codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later in the proper place in the Code.

The following proposed revisions have been approved for publication as proposed addenda to the Code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the Code, and are submitted for criticism and approval from any one interested therein. It is to be noted that a proposed revision of the Code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th Street, New York, N. Y., in order that they may be presented to the Committee for consideration.

Revisions

PAR. P-14. Revised:

P-14. *Tensile Strength of [Steel] Plate.* In determining the maximum allowable working pressure, the tensile strength used in the computations for [steel] plates shall be that stamped on the plates (NAMELY, the minimum of the SPECIFIED [stipulated] range), as provided in THE SEVERAL specifications [S-1 for Steel Boiler Plate which is] [or 55,000 lb per sq. in. for all steel plates, except for special grades having a lower tensile strength.]

PAR. P-15. Revised:

P-15. *Crushing Strength of Steel Plate.* The resistance to crushing of steel plate [shall be taken at 95,000 lb] per square inch of cross-sectional area SHALL BE TAKEN AS FOLLOWS:

MATERIAL	SPEC. NUMBER	CRUSHING STRENGTH
FLANGE AND FIREBOX	S-1, S-26, S-27,	95,000
ALLOY STEEL	S-28, GRADE A, GRADE B	120,000

PAR. P-16. Add the following to tabular matter:

ALLOY STEEL, SPECIFICATIONS S-28, GRADE A SINGLE SHEAR 60,000

ALLOY STEEL, SPECIFICATIONS S-28, GRADE A DOUBLE SHEAR 120,000

PAR. P-102*e*. Add the following note to the second section:

(THE TENSION TEST OF THE JOINT SPECIMEN AS SPECIFIED HEREIN IS INTENDED AS A TEST OF THE WELDED JOINT AND NOT OF THE PLATE.)

PARS. P-102*i* and U-68*i*. Add the following to first sections:

THE JOINTS SHALL BE STRESS RELIEVED AND THEN RADIOGRAPHED WHEN THE THICKNESS OF THE METAL DEPOSITED IN THE WELD IS 4¼ IN. THE JOINTS SHALL ALSO BE STRESS RELIEVED AFTER THE COMPLETION OF THE WELDED JOINT.

PAR. P-104. First section, and Par. U-72*c*. Revised:

If the thickness of the flange of a head to be attached to a cylindrical shell by a butt joint exceeds the shell thickness by more than 25 percent (maximum ¼ in.), the flange thickness shall be reduced at the abutting edges EITHER ON THE INSIDE OR THE OUTSIDE, OR BOTH, as shown in Fig. P-6 (U-18*a*).

PAR. P-258. Revised last sentence:

A handhole, INSPECTION OR WASHOUT opening in a shell or UNSTAYED HEAD [of a boiler drum in which the dimension in the longitudinal direction exceeds the allowable size of an unreinforced opening given in Par. P-268*a*, or in which the greatest dimension exceeds 6 in.,] shall be DESIGNED [reinforced] in accordance with the rules GIVEN in Par. P-268*b*.

PAR. P-260. Add the following:
MANHOLE FRAMES MAY ALSO BE ATTACHED BY WELDING PROVIDED THE REQUIREMENTS OF PARS. P-101 TO P-111, INCLUSIVE, OMITTING THE X-RAYING, AND PAR. P-268 ARE MET.

PARS. P-268*d* and U-59*v*. Add the following as new sections:
d (*v*) IF THE UNIT TENSILE STRENGTH OF ANY MATERIAL USED FOR REINFORCEMENT IS NOT EQUAL AT LEAST TO THAT OF THE VESSEL WALL TO BE REINFORCED, ADDITIONAL REINFORCEMENT SHALL BE ADDED TO COMPENSATE FOR THE LOWER TENSILE STRENGTH.

PAR. P-278. Revised second sentence:
In the case of fire-tube boilers, the openings in the boilers for safety valves AND THE OUTLET OPENING OR OPENINGS OF ANY INTERVENING FITTINGS shall not be less than given in Table P-15 for capacities determined in accordance with Par. P-274.

PAR. P-288*a*. Insert the following as second sentence: IF THE SUPERHEATER OUTLET HEADER HAS A FULL, FREE, STEAM PASSAGE FROM END TO END AND IS SO CONSTRUCTED THAT STEAM IS SUPPLIED TO IT AT PRACTICALLY EQUAL INTERVALS THROUGHOUT ITS LENGTH SO THAT THERE IS A UNIFORM FLOW OF STEAM THROUGH THE SUPERHEATER TUBES AND THE HEADER, THE SAFETY VALVE, OR VALVES, MAY BE LOCATED ANYWHERE IN THE LENGTH OF THE HEADER.

PAR. P-299. Add the following to fifth section:
IT IS RECOMMENDED THAT CAST-IRON VALVES AND FITTINGS BE NOT USED FOR THIS SERVICE FOR PRESSURES OVER 200 LB PER SQ IN., UNLESS THE FLANGE AND BODY THICKNESSES ARE INCREASED TO MAINTAIN THE SAME DEFLECTION LIMITS AND TO GIVE AT LEAST THE SAME FACTOR OF SAFETY AS SPECIFIED FOR THE 250 LB STANDARD, IN WHICH CASE SUCH STRENGTHENED VALVES OR FITTINGS MAY BE USED UP TO 250 LB MAXIMUM ALLOWABLE WORKING PRESSURE. STEEL VALVES AND FITTINGS MAY BE STRENGTHENED FOR USE AT PRESSURES EXCEEDING THEIR NOMINAL RATING BY INCREASING THE FLANGE AND BODY THICKNESSES TO MAINTAIN THE SAME DEFLECTION LIMITS AND TO GIVE THE SAME FACTOR OF SAFETY AS SPECIFIED FOR THE NEAREST STANDARD-PRESSURE RATING.

PAR. P-307. Revised last sentence:
A properly designed [brass or] steel bushing, similar to or equivalent of those shown in Fig. P-30, or a flanged connection, shall be used.

PAR. P-325. Designate the first sentence as (*a*), the remainder of the paragraph as (*b*), and add a new section (*c*) as follows:

c LUGS, HANGERS, OR BRACKETS OF THE SAME SIZE AS REQUIRED FOR RIVETING AND MADE OF MATERIALS IN ACCORDANCE WITH THE CODE REQUIREMENTS MAY BE ATTACHED BY FUSION WELDING PROVIDED THE WELDING MEETS THE REQUIREMENTS OF PARS. P-101 TO P-111, INCLUSIVE, INCLUDING STRESS RELIEVING BUT OMITTING RADIOGRAPHIC EXAMINATION, AND PROVIDED THEY ARE ATTACHED BY FILLET WELDS ALONG THE ENTIRE PERIPHERY OR CONTACT EDGES, OF THE SIZE AND FORM SHOWN IN SKETCHES 1 TO 4, INCLUSIVE, IN FIG. P-7 IN WHICH t^n REPRESENTS THE SHELL THICKNESS. THE STRESSES COMPUTED BY DIVIDING THE TOTAL LOAD ON THE LUG, HANGER, OR BRACKET BY THE MINIMUM CROSS-SECTIONAL AREA OF THE WELD SHALL NOT EXCEED, FOR TENSION AND COMPRESSION 40 PERCENT, AND FOR SHEAR 32 PERCENT OF THE STRESS VALUES GIVEN IN TABLE P-8 MULTIPLIED BY THE WELDED-JOINT EFFICIENCY.

PARS. P-332, L-82, H-68 and H-120, M-20 and U-66. Cancel proposed addition published in the February issue of *Mechanical Engineering* and substitute the following:
PERMISSION TO USE THE SYMBOL DESIGNATED IN THE FOREGOING PARAGRAPH WILL BE GRANTED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS TO ANY MANUFACTURER COMPLYING WITH THE PROVISIONS OF THIS CODE WHO WILL AGREE UPON FORMS ISSUED BY THE SOCIETY THAT ANY VESSEL TO WHICH THE SYMBOL IS APPLIED WILL BE CONSTRUCTED IN FULL ACCORDANCE WITH THE CODE REQUIREMENTS AND THAT HE WILL NOT MISUSE OR ALLOW OTHERS TO USE THE STAMP BY WHICH THE SYMBOL IS APPLIED. A STEEL stamp[s] for APPLYING the [official] symbol [shown in Fig. P-33] MAY BE PURCHASED BY SUCH MANUFACTURER [are obtainable] from the [American] Society [of Mechanical Engineers.]

SPECIFICATIONS S-15. Insert the following as Par. 2:

2 CASTINGS SHALL BE FREE FROM PRIMARY GRAPHITE.

SPECIFICATIONS S-17, PAR. 17. Revised:
17 *Marking.* *A* The name or brand of the manufacturer, the grade of material from which it is made, whether SEAMLESS OR lap-welded, AND WHETHER steel or iron, TOGETHER WITH [and] the hydrostatic pressure in pounds at which it was tested, shall be legibly stenciled on each tube 1¼ IN. IN OUTSIDE DIAMETER AND OVER, PROVIDED THE LENGTH IS NOT UNDER 3 FT.
B ON TUBES LESS THAN 1¼ IN. IN DIAMETER AND ON ALL TUBES UNDER 3 FT. IN LENGTH, THE NAME OR INITIALS OR BRAND OF THE MANUFACTURER SHALL BE LEGIBLY STENCILED OR INDICATED ON A STICKER APPLIED ON EACH TUBE.

Tube Cleaner for Small Boiler Tubes

A new cleaner, especially designed for small diameter curved tubes of modern marine and naval boilers, has just been announced by the Roto Company, Newark, N. J. The new air-driven cleaner, called the Roto Junior is entirely self-contained, and considering its small size it has unusual power and speed in removing scale. Its outstanding features are its simplicity, having only two moving parts, and its ease of handling which permits a number of cleaners to be operated simultaneously in the same boiler. This allows more frequent cleaning resulting in a higher average boiler efficiency. The Roto Junior is designed for straight tubes as small as ⅝ inch outside diameter and curved tubes with short radius bends as small as ⅞ inch outside diameter.

The present trend in marine boiler design is toward smaller diameter curved tubes, but engineers have been handicapped because of their inability to find a suitable cleaner. The Roto Junior operates on the Rotocentric principle which has been an exclusive feature of the company's larger cleaners since 1910. Very little headroom is required, and either horizontal or vertical tubes can be cleaned. It has none of the disadvantages of the old external cleaner which required a large, cumbersome motor, a long extension or flexible shaft which frequently broke, a trolley or block-and-tackle for suspending the motor, high initial cost, etc.

A circular describing the new Roto Junior may be secured by writing to the Roto Company, 141 Sussex Avenue, Newark, N. J.

MARINE BOILERS—III*

By Captain C. A. Jones, U. S. N.† and Lieutenant Commander T. A. Solberg, U. S. N.‡

(*f*) *Circulation.* Circulation of the steam water mixtures in naval boilers merits special consideration because of the high steaming rates at which they are forced. Considerable experimentation has been conducted at the Naval Boiler Laboratory to determine the character of circulation in many types of express boilers. While efficiencies may be affected to an inappreciable extent by inadequate circulation, the life of the boiler may be jeopardized by it.

The attention of Naval Boiler Laboratory engineers first was directed to circulation by the fact that marks indicating the presence of a water level were found in the water (mud) drums of one of the Laboratory's express boilers. Further examination showed that heavy pitting had occurred below the *A* row tube ends. This was found to be caused by radiant heat absorption of the drum through an exposed area immediately below the *A* row tube ends. Checking the condition of the water drums of similar boilers in the Fleet showed that pitting had occurred in the same positions for the same reason. Gage glasses therefore were installed at the ends of the water (mud) drums. These gages indicated the presence of a water level or a steam pocket which could be eliminated either by covering the exposed parts of the drum or by the use of 4-inch external downcomers carrying water from the steam drum to each of the mud drums.

Further experimentation then was conducted by use of long column gage glasses and other devices for ascertaining the density of water in the tube banks of the boilers. This work has been discussed exhaustively by Rear Admiral S. M. Robinson in his paper entitled "Water Circulation and Gas Path in Naval Boilers," *Transactions* of The Society of Naval Architects and Marine Engineers, 1933.

Three of the most important results of this work have been: Ascertainment of the fact that the water (mud) drums should not be exposed to radiant heat or allowed to generate steam due to the passage of hot gases over large unprotected areas of their surfaces; determination of the necessary head available for circulation, if loss of tubes is to be avoided; and determination of the influence of downcomers and the size of downcomers required for increasing the head available for circulation. It is considered, also, that no extensive areas of the steam drum, especially at the bottom should be exposed to radiant heat or hot gases, as this not only may cause overheating in the drums, but also creates undesirable disturbances in the steam drum, especially when rapid load changes are made. The Laboratory is now engaged in further work concerning circulation in boilers designed for present and future construction.

A careful consideration of the matter of circulation in *A*-type boilers casts serious doubts on the arrangements usually provided. It is undeniable that practically all the water evaporated must first pass through the mud drums. It is well known, also, that the tubes which provide the flow of water to these drums are the rear tubes in the banks. These tubes usually have the least available hydraulic head to insure a downward flow of water. Any head deficiency must be supplied by the aspirating or suction effect of upward flow in tubes (upcomers) generating steam. Although the rear or downcomer tubes may absorb enough heat to evaporate some of the water, they invariably still act as downcomers. Practically all of the feed entering the steam drum attains the saturation temperature before entering the downcomer tubes. It follows, therefore, that any downcomer tube absorbing heat will deliver varying quantities of steam bubbles to the mud drum.

This is likely to interfere with circulation and is manifestly undesirable because the principal function of the mud drums is to deliver water to the steam generating tubes. The use of small tubes for downcomer purposes is uneconomical as regards space and weight. It seems, therefore, that boilers of this general type, when operated at high evaporating rates, should be designed with adequate unheated downcomers. The exact condition under which this becomes a necessity is still to be determined.

Another means for assisting the circulation, devised by Captain H. C. Dinger, U. S. N., (Retired), consists of providing a special baffle and feed line arrangement in the steam drum which directs the flow of the incoming feed to the last rows of tubes (downcomers).

The provisions for circulation in most header-type boilers are excellent, provided the connecting nipples between the headers and the steam drum are ample in size, and provided the rate of evaporation is not too high. At high rates of evaporation there is undoubtedly some interference with circulation in the upcomer headers due to the discharge of steam and water across the direction of flow. Circulation problems are apparently unknown in commercial practice, first because the natural allowances in the design are ample, and second because operating conditions are different. It is easy to see why circulation deficiencies were noted first in naval boilers with their cramped design and high operating rates.

(*g*) *Length of Boiler Tubes.* The caliber lengths (length/diameter) of the fireside row tubes in the majority of naval express boilers range from about 70 to 126. It is believed that the caliber lengths should not exceed the latter figure. Many designers provide low caliber length by using relatively large diameters in the fireside rows. Experiments conducted at the Naval Boiler Laboratory under conditions of good circulation have shown that increase in caliber length beyond this figure soon is accompanied by ejection of highly superheated steam to the steam drum, resulting in elevated tube temperature, because of the fact that the upper portion of the high-caliber tubes is not adequately water cooled. During one experiment, when tubes of 207 and 263 calibers were installed in the fireside rows of a 7565-square-foot White Forster boiler, the superheat at the 1-pound combustion rate, which is in the order of 400 percent of rating according to stationary practice, reached

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* Third instalment of a paper read before The Society of Naval Architects and Marine Engineers, New York, November 16, 1934.

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272 degrees F. After about four hours' operation at this superheat, the tube became badly blistered and split on account of heavy external oxidation. A large amount of data concerning the caliber length of tubes has been amassed, but as yet definite conclusions are not considered justified for the entire range covered.

There is a definite objection to using tubes of large diameter in marine practice, because of the much more serious consequence if a tube lets go in the confined fireroom in which the boilers are installed.

(*h*) *Steam Drum.* The manner in which the steam generated by the heating surface enters the steam drum is an important factor in determining the steam baffling necessary to provide substantially dry steam. The Bureau of Engineering has specified that the quality of steam before the superheaters shall not be less than 99.5 percent at full power under all ordinary water level and water concentration conditions.

Steam enters the steam drums of *A*-type boilers well below the water level; the fireside rows, which generate a very large portion of the total output, cause geysering of the steam drum water. Use of *V*-type perforated submerged baffles as developed by Commander H. G. Donald, U. S. N., produces steam of specification quality in most *A*-type express boilers where the steam enters the drum below the water level.

In cases where the fireside tubes enter the steam drum above the water level, considerable trouble from wet steam often is encountered. Baffling of the general type used in Babcock and Wilcox cross-drum boilers has proved satisfactory in some of these cases.

The entrance of steam to the steam drum by way of comparatively large return tubes, as in the case of certain inclined-tube boilers with relatively small diameter steam drums, sometimes necessitates the use of more complicated steam baffling. This is considered most undesirable from a maintenance and inspection point of view.

(*i*) *Furnace.* The furnaces of naval boilers are relatively small, ordinarily approximating in volume about one-tenth of the number of square feet in the boiler water heating surface. Heat releases, it is to be expected, are correspondingly high. Whereas, the heat releases in shore plants rarely exceed 50,000 B.t.u. per cubic foot of furnace volume per hour and more nearly average 20,000, it is common practice to operate naval boilers at 100,000 B.t.u. per cubic foot of furnace volume per hour. This figure exceeds 200,000 at full power. The Naval Boiler Laboratory under test conditions has operated boilers occasionally at heat releases reaching 350,000 B.t.u. per cubic foot of furnace volume per hour.

The heat release possible in boiler furnaces naturally is limited by the life of the refractory which may be economically used and by the furnace temperature. Furnace temperature is influenced not only by the volumetric rate of heat release, but also by the radiant heat absorption surfaces of the boiler, or fraction cold (projected area of heating surface in furnace divided by area of refractory surface).

The speed of combustion in boiler furnaces is accelerated by increased temperature in the same manner that the speed of practically all chemical reactions is hastened by increase in temperature. In other words, as the furnace temperature increases, the portion of the furnace volume actually occupied by burning gases decreases for any given rate of heat liberation and therefore reduces the surface from which radiation occurs.

Similarly, the more rapid the combustion the less the space and time required for completion of oxidation of given sized particles. The possibility of chilling by direct contact with cold surfaces under these conditions is lessened. High furnace temperatures accompanying high heat release are desirable because of this increased speed of combustion, particularly with highly cracked fuel oils ant in those marine installations which burn pulverized coal.

In small or constricted furnaces the speed of combustion must be high in order to burn thoroughly the hydrocarbon gases and carbon particles before they pass into the tube banks, because the chilling which is caused by the tubes practically precludes further combustion. This factor is largely responsible for the falling off of the boiler efficiency curves as the combustion rate increases.

It is desirable that furnace temperatures and heat releases in naval or marine boiler furnaces be as high as is compatible with the life of the refractories, even though expensive special materials are required.

It is felt that there is a most promising field for improvement in the weight characteristic, longer refractory life and cooler firerooms at higher combustion rates by the use of air casings around the boiler. An experiment covering this feature was started at the Boiler Laboratory in 1929 and the preliminary results were very encouraging. Due to the press of other work it had to be discontinued but it is the intent to take it up again as early as practicable. Some previous experience had been obtained in actual service with air casings on the boilers of the *Lexington* and *Saratoga* and in a recent vessel definitely high fireroom temperatures were successfully corrected by this method.

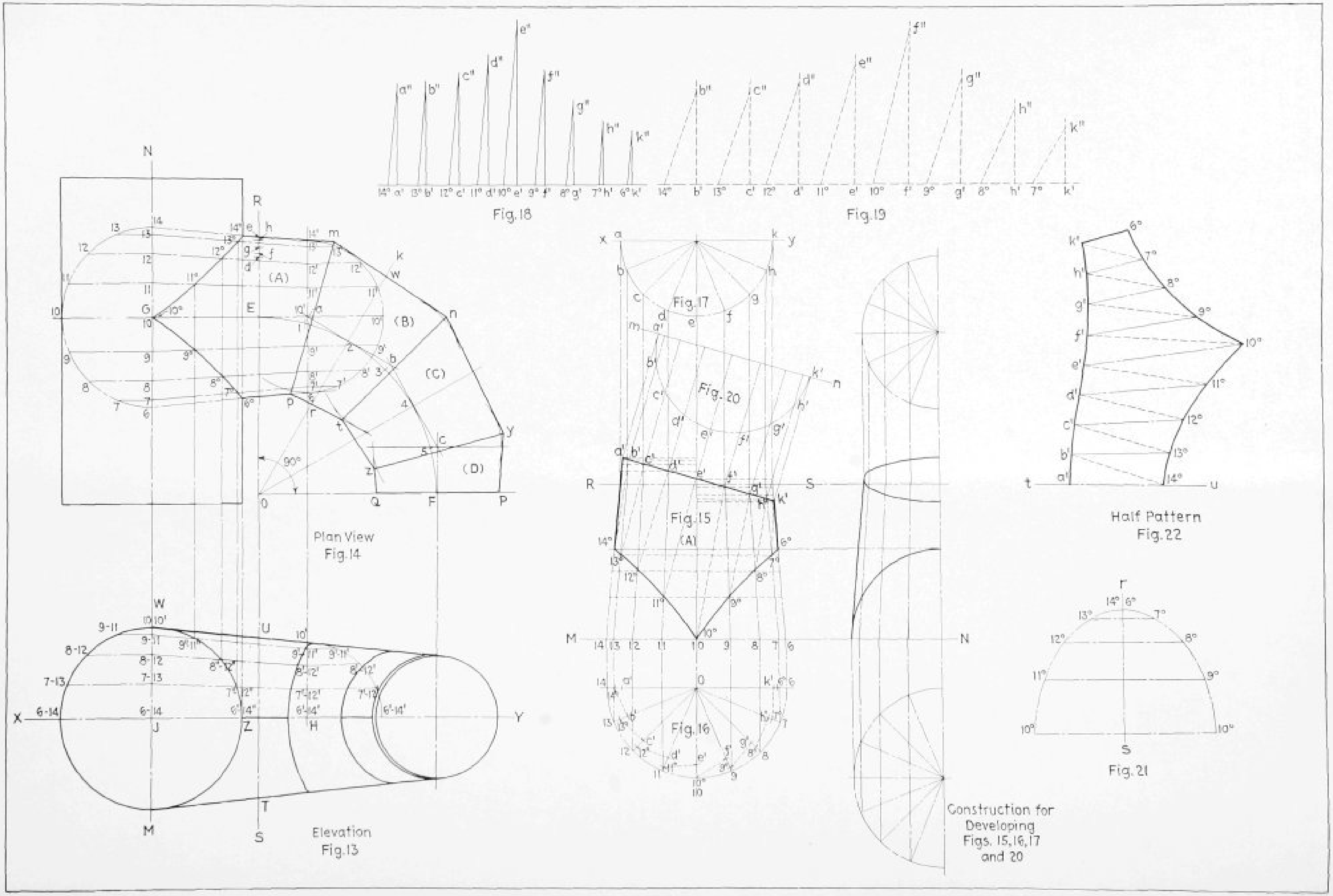
Cool surfaces decrease the speed of combustion. Water-cooled walls therefore are not considered applicable to naval practice. In shore plants, where very large furnaces are possible, water-cooled walls have been adopted quite generally. Because of the large furnaces and the low rates of heat release, these walls do not have the marked influence on combustion conditions which occur in small furnaces. Exposed water walls are an expensive form of heating surface as regards weight, first cost, and maintenance. Their use is not a means of obtaining heat which would otherwise be lost. Radiant heat absorbed by them is at the expense of the remaining generating and superheating surfaces, as the mean temperature difference in the tube bank is reduced by this absorption. Water-wall furnaces invariably require higher air pressures and more excess air for satisfactory combustion, and net efficiencies are reduced thereby.

The small furnaces used in naval and most marine boilers practically preclude the use of water-walls. It should be remembered, however, that with properly bricked and insulated furnaces, little heat is lost through the furnace walls. Most of these losses are regained by the consequent heating of the fireroom air which is eventually used for combustion in the furnace. A balance must be struck between the casing temperature in wake of the furnace and the thickness of heat insulation. On the one hand insufficient insulation means hot firerooms, possible fire hazard and danger to personnel, while too much insulation means short life of the refractory, increased weight and increased space.

In the interest of saving weight the Navy made the mistake a few years ago of decreasing the refractory thickness and increasing the insulation thickness with a resultant rapid loss of the furnace wall due mainly to the rapid oxidation of the brick retaining bolts. From this there was developed the use of ferro-manganese bolts and lately Inconel bolts which withstand much higher temperatures before oxidation. Many shore plant boiler settings no doubt would be improved by using a well designed but smaller refractory furnace and net installation and upkeep costs would be lessened thereby.

The minimum length of furnace which can be satis-

(*Continued on page 107*)



Figs. 13 to 22.—Details of tapered elbow connection layout

PRACTICAL PLATE DEVELOPMENT—II

Tapered Elbow Connection

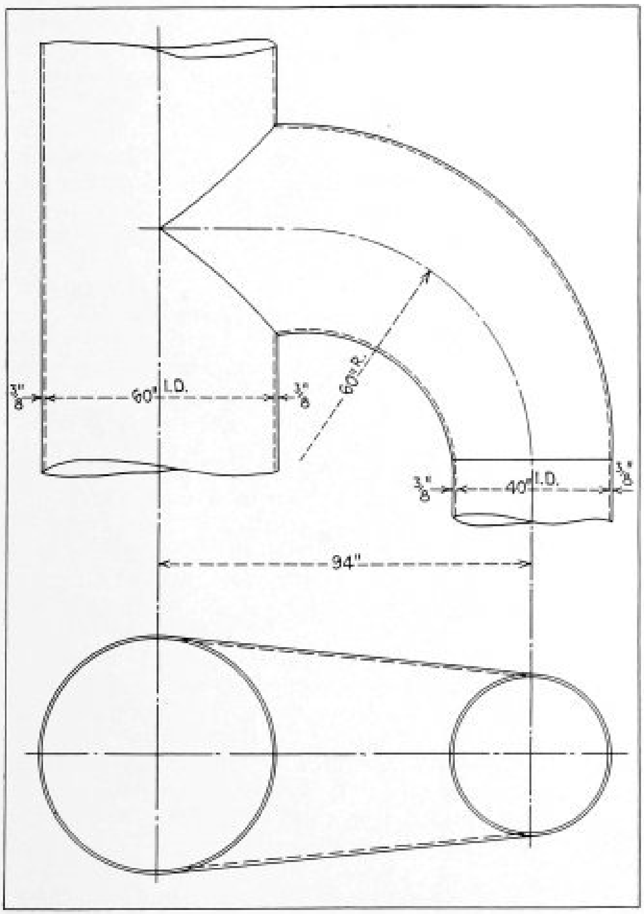


Fig. 12.—Problem to develop a tapered elbow connection

By George M. Davies

This article covers detailed instructions for the first part of a tapered elbow connection development. Because of the complicated nature of this layout, it was thought best to divide it into two instalments, so that readers would be able to give more time to a study of the principles involved than would be possible if the entire problem were presented in a single issue. Because the entire layout is necessary for a complete understanding of this type development, Practice Problem No. 2 will not be published until the tapered elbow connection has been completed in the June issue. The correct layout for Practice Problem No. 1 will also be published in June

Pipe line feed and by-pass lines often require a tapered elbow connection as shown in Fig. 12, which illustrates a 60-inch inside diameter pipe, with a 40-inch inside diameter feed or by-pass pipe, the feed or by-pass being joined to the main pipe with a tapered elbow connection. The connection is of welded construction.

To develop the patterns for the various parts of the connection, the first step is to lay out the elevation, Fig. 13, and the plan view, Fig. 14, to the dimensions given in Fig. 12, using the neutral diameter of the pipes for the outline.

The first step in the development is to obtain the miter lines of the tapered elbow and also the connection of the tapered elbow and the main pipe as shown in the plan view, Fig. 14, as follows:

Through the center of the radius of the elbow connection draw the line *R-S* parallel to the center line *M-N*. The line *R-S* cutting the outline of the elevation at *U-T*, making *U-T* the diameter of the elbow connection along the line *R-S*. At *O* draw the line *O-P* at 90 degrees to *R-S*, forming the right angle tapered elbow having a diameter *U-T* at the large end and *P-Q* at the small end.

With *O* as a center strike a quarter of a circle *E-F*, the radius being taken as shown in Fig. 12. Determine the number of sections wanted in the elbow and multiply by two. This elbow is to be made in three sections, two whole and two half. Section (*B*) and (*C*) being the whole sections and (*A*) and (*D*) being the half section. Section (*A*) also includes the connection to the main pipe, but for the purpose of determining the miter lines for the elbow connection, the part inside of the line *R-S* is included in the right angle tapered elbow and this part is considered as a half section.

As stated above, this is a three-section elbow and $3 \times 2 = 6$; then divide the quarter circle *EF*, Fig. 14, into six equal parts, and number the points from *1* to *5* as shown. After having done this draw lines from *O* through the points *2* and *4*. On the points *E*, *2*, *4* and *F* at right angles to the radial lines and tangent to the circle, draw straight lines of an indefinite length intersecting each other at *a*, *b* and *c*. Then on the line *O-R*, set off the half diameter of the large end *U-T* on each side of the center *E* and on the line *O-P* set off the half diameter of the small end, taken from Fig. 12, on each side of the center *F*.

In order to get a regular taper it is necessary to have the diameters of the ends of the different sections at the miter lines. To determine these, set off on the line *E-R*, from *E*, the half diameter of the small end, which leaves the distance *d-e* as the difference of half the diameters of the two ends. This difference must be divided into three equal parts, consisting of two whole and two half parts, just as the elbow is divided into two whole and two half sections, and the half parts should be at the ends as shown. Then the distance *E-f* is the half diameter on the joint line *5*; the distance *e-g* is the half diameter on the joint line *3* and the distance *E-h* is the half diameter on the joint line *1*.

Take these half diameters as radii, and from the intersections *a*, *b*, *c* as centers, strike arcs of the circles at the back and in the throat; then by drawing straight lines tangent to these arcs, the back and throat are produced. By connecting the joints of the intersection of these lines at the back and in the throat with lines, the different sections as *(A)*, *(B)*, *(C)* and *(D)* are defined, completing the outline and miter lines of the elbow portion of the connection.

The miter lines of the intersection of the elbow and the pipe are obtained as follows: Extend *a-E*, cutting center line *M-N* at *G*. Through *(a)* in the plan view, Fig. 14, draw a line parallel to *M-N* extending same into the elevation, cutting *X-Y* at *H*. With *G* as a center and with a radius equal to one-half the diameter of the pipe, describe a semicircle, as shown. Divide the semicircle into eight equal spaces and number same from *6* to *14* as shown. Then parallel to *G-E* draw lines through these points, cutting the center line *M-N*. Number the points correspondingly as *6* to *14* as shown. Then with *(a)* as a center and with a radius equal to *E-h* scribe a semicircle as shown. Divide this semicircle into the same number of equal parts as taken before, number these points from *6'* to *14'* as shown. Parallel to *G-E* draw a line through the points *6'* to *14'*, cutting the line *a-H*; number the points correspondingly as *6'* to *14'*. Connect to point *6-6'*, *7-7'*, *8-8'* to *14-14'* as shown in the plan view, Fig. 14. Then with *H* as a center scribe a quarter circle and divide same into four equal parts, number the divisions corresponding to the numbers for the same points in the plan view as *6'*, *10'* and *14'* as shown.

Next divide the quarter circle *X-W* in the elevation into four equal parts. Number the divisions corresponding to the numbers for the same points in the plan view *6*, *10* and *14* as shown. Parallel to *X-Y* draw lines, through the point *6'*, *10'* and *14'*, cutting the line *a-H* locating the points *6'*, *10'* and *14'* and also through points *6*, *10* and *14* cutting the line *J-W*, locating the points *6*, *10* and *14* in the elevation. Connect the points *6-6'* to *14-14'* and where these lines cross the quarter circle *W-Z* locates the points *6"* to *10"* to *14"* in the elevation.

Then parallel to *M-N*, draw a line through the points *9"* and *11"* in the elevation and extend same into the plan cutting the lines *9-9'* and *11-11'* locating the points *9°* and *11°* in the plan. In like manner draw a line through the points *8"* and *12"* in the elevation and extend same into the plan cutting the lines *8-8'* and *12-12'*, locating the points *8°* and *12°*. Continue in this manner until the points *7°*, *13°*, *6°*, *14°* are located. Draw a line through the points *6°* to *10°* and *10°* to *14°*, completing the miter lines between the elbow and pipe. The plan and elevation views are complete and the final shape and correct dimensions are determined.

Development of Pattern (A)

In order not to get too many lines piled on top of one another, make a separate drawing of the end section (A) as shown in Fig. 15.

Extend the center line above and below Fig. 15 so as to be able to lay out Figs. 16 and 17 on it.

The miter lines are obtained in the same manner as outlined in the plan and elevation, Figs. 13 and 14, and the points are numbered correspondingly. Next above Fig. 15 erect Fig. 17 by drawing horizontal line *x-y* and with a radius equal to *E-h*, Fig. 14, strike a half circle and divide it into eight equal parts; number same from *a* to *k* as shown. Then through Fig. 15 draw horizontal line *R-S*, the same height from the base line *14°-6°*, as the point *a*, Fig. 14, is out from point *E*. Then project the points *a*, *b*, *c*, *d*, *e* to *k*, Fig. 17, down onto the line *R-S*, Fig. 15. From the points *6* to *14* on the center line *M-N*, Fig. 15, draw lines through the points on *R-S*, cutting the miter line and establishing the points *a'* to *k'*.

Connect the points *a'-14°*, *b'-13°*, *c'-12°*, etc., to *k'-6°* with full and dotted lines as shown, these lines being the surface lines of a series of right angle triangles whose altitudes are the vertical distances between the point *6°-k'*, *7°-h'* to *14°-a'*, Fig. 15, and whose bases are determined as follows: Extend *6°-k'* above *k'*. Then parallel to *R-S* draw horizontal dotted lines through the points *a'* to *k'* and *6°* to *14°*, extending same from the center line out to the surface lines *6°-k'* and *a'-14°*.

In Fig. 16 connect the points *6* to *14* with the center *O*. Then with *O* as a center and with the trams set equal to the length of the horizontal dotted line through the point *a'*, Fig. 15, as a radius, scribe an arc cutting the line *O-14* locating the point *a'*, Fig. 16. Then with *O* as a center and with the trams set equal to the length of the horizontal dotted line through the point *b'*, Fig. 15, as a radius, scribe an arc cutting the line *O-13* locating the point *b'*, Fig. 16. Continue in this manner until the points *c'*, *d'*, *e'* to *k'* are located. In the same manner locate the points *6°* to *14°*, Fig. 16, using the length of the horizontal dotted line, each side of the dotted line, through the points *6°* to *14°*, Fig. 15. Connect the points *a'-14°*, *b'-13°*, *c'-12°*, *d'-11°*, etc., with full lines and *14°-b'*, *13°-c'*, etc., with dotted lines, as shown. These distances form the bases of the right angle triangles shown in Figs. 18 and 19.

Next construct a series of right angle triangles as shown in Figs. 18 and 19.

Draw a horizontal line, Fig. 18, and step off the distances *14°-a'*, *13°-b'*, etc., to *6°-k'* equal to these corresponding distances in Fig. 16. On the vertical to *a'* set off the distance *a'-a"* equal to the vertical distance between the points *14°-a'*, Fig. 15. The hypotenuse of this triangle *14°-a"* is the true length of the solid surface line *14°-a'*, Fig. 15. In the same manner complete the triangles in Fig. 18 taking the altitudes equal to the vertical distance between the points *13°-b'*, *12°-c'*, *11°-d'*, *10°-e'* to *6°-k'*, Fig. 15, completing the solid surface lines.

Next draw a horizontal line, Fig. 19, and step off the distances *14°-b'*, *13°-c'*, 12°*-d'*, etc., to *7°-k'* equal to the corresponding distances in Fig. 16. On the vertical to *b'* set off the distance *b'-b"* equal to the vertical distance between the points *14°-b'*, Fig. 15. The hypotenuse of this triangle *14°-b'* is the true length of the dotted surface line *14°-b'*, Fig. 15. In the same manner complete the triangles in Fig. 19 taking the altitudes equal to the vertical distances between the points *13°-c'*, *12°-d'*, *11°-e'* to *7°-k'*, Fig. 15, completing dotted surface lines.

The next step is to obtain the true length of the miter line *a'-k'*, as shown in Fig. 20. Draw *m-n* parallel to *a'-k'*. Then perpendicular to *a'-k'*, draw lines through the points *a'-b'-c'* to *k'*, Fig. 15, extending same into Fig. 20, cutting the line *m-n*.

On the perpendicular to point *b'*, Fig. 15, step off from the line *m-n* a distance equal to the vertical distance from the line *14-6* to the point *b'*, Fig. 16, locating the point *b'*, Fig. 20. In like manner on the perpendicular to point *c'*, Fig. 15, step off from the line *m-n* a distance equal to the vertical distance from the line *14-6* to the point *c'*, Fig. 16, locating the point *c'*, Fig. 20. Locate the points *d'*, *e'*, *f'* to *k'*, Fig. 20, in like manner.

Connect these points with a line which will be the profile of the miter line *a'-k'*, Fig. 15.

The next step is to obtain the true length of the miter lines *6°-10°* and *10°-14°* as shown in Fig. 21. Draw the perpendicular *r-s* and step off distances equal to *10°-9°*, *9°-8°*, *8°-7°* and *7°-6°* of Fig. 15. Then step off on each side of the line *r-s* a distance equal to the distance *O-10°*, Fig. 16, locating the point *10°* each side of the line *r-s* as shown. Then step off on each side of the line *r-s* a distance equal to the vertical distance between the line *14-6* and the points *9°* and *11°*, Fig. 16, locating the points *9°* and *11°*, Fig. 21. Continue in this manner locating the points *8°*, *7°*, *6°*, *14°*, *13°*, and *12°*, Fig. 21. Connect the points with a line which will be the miter line *6°-10°* and *10°-14°*.

Constructing the Pattern

Before constructing the pattern it will be noted in Fig. 13 that the line *X-Y* divides the object into two symmetrical halves and therefore a pattern of one-half and any part can be duplicated to make a full pattern.

The seam is taken along the line *6°-k'* as shown in Fig. 15.

Draw a horizontal line as *t-u* and step off *a'-14°* equal to *a'-14°*, in Fig. 15. Then with *a'*, Fig. 22, as a center and with the dividers set equal to *a'-b'*, Fig. 20, scribe an arc; then with *14°*, Fig. 22, as a center and with the trams set equal to *14°-b"*, Fig. 19, scribe an arc cutting the arc just drawn, locating the point *b'*, Fig. 22. Then with *14°*, Fig. 22, as a center and with *14°-13°*, Fig. 21, as a radius, scribe an arc. Then with *b'*, Fig. 22, as a center and with the trams set equal to *13°-b"*, Fig. 18, as a radius, scribe an arc cutting the arc just drawn, locating the point *13°*, Fig. 22.

Continue in this manner making *b'-c'*, *c'-d'*, etc., to *h'-k'*, Fig. 22, equal to *b'-c'*, *c'-d'* to *h'-k'*, Fig. 20, and *13°-12°*, *12°-11°*, *11°-10°*, to *7°-6°*, in Fig. 22, equal to *13°-12°*, *12°-11°*, *11°-10°*, to *7°-6°* in Fig. 21.

The lengths of the solid lines are taken from the right angle triangles in Fig. 18 and the lengths of the dotted lines are taken from the right angle triangles in Fig. 19.

Connect these points thus located completing the half pattern, Fig. 22.

(To be continued)

Brooklyn Distributor for Toncan Iron.—Appointment of Atlas Supply Company, Inc., 35-39 Woodward Avenue, Brooklyn, N. Y., as warehouse distributors of rust-resisting Toncan Iron sheets has been announced by N. J. Clarke, vice-president in charge of sales, Republic Steel Corporation, Youngstown, O.

Work of the A. S. M. E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information on the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th Street, New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published.

Following are records of the interpretations of this Committee formulated at the meeting of February 8, 1935, and approved by the Council.

Case No. 527
(Annulled because of revision of Par. P-258)

Case No. 765
(Annulled)

Case No. 779
(Annulled)

Case No. 802—(*Interpretation of Pars. P-104 and U-72*)

Inquiry: Is it permissible under the requirements of Pars. P-104 and U-72 of the Code to shape the scarfs of welding edges by flame cutting?

Reply: It is the opinion of the Committee that if the welding edges of steel plates, containing not to exceed 0.35 percent carbon, are formed by flame cutting so that they are uniform and smooth, and are free from slag and scale accumulations, the welds may be applied thereon without conflict with the Code rules. The discoloration which may remain on the flame-cut surface is not considered to be detrimental oxidation.

Marine Boilers

(Continued from page 103)

factorily used is a point of vital importance in naval design and one which has not yet been determined. There is undoubtedly an intimate relation between this minimum length and the distance of the burner from the tube bank. It is the opinion at present that if the distance of the burner from the tubes is increased the furnace can be materially shortened from the length formerly considered necessary. This theory will shortly be investigated at the Boiler Laboratory.

(*j*) *Gas Paths.* The most efficient heat transfer is obtained if the gas traverses the tubes at high velocity in a direction normal to their axis. Despite this well-known fact, many boilers are built with elaborate baffling, forcing the gases to travel along the tube length. In general, baffles are undesirable and should be avoided. They are difficult to replace, and it is equally impracticable to determine when they are no longer tight or have deteriorated to such an extent that wasteful leakage occurs.

(To be continued)

Fifty Years of Service

In January two executives of the Hartford Steam Boiler Inspection and Insurance Company celebrated the completion of fifty years of active work in the organization. On New Year's day, William M. Francis, manager of the Atlanta Department, celebrated his fiftieth anniversary, and on March 1, Secretary Louis F. Middlebrook completed his half century of prominent service.

Secretary Middlebrook has been connected with the home office and the administrative end of the business since 1885. He began as a clerk and stenographer under the late Secretary J. B. Pierce, and was promoted to the rank of assistant secretary under Mr. Pierce in 1897. His appointment to the position of secretary was made in 1921.

Manager Francis began his career at the age of 16 as office boy at the home office. Five years later he was transferred to the inspection force, and in 1893 began his work with Southern assured, first as an inspector and special agent, and later in charge of inspection activities in the Charleston territory. In 1898 Mr. Francis was transferred to the Atlanta office, where, in 1900, he was made chief inspector. With the consolidation of the Charleston and Atlanta departments in 1909, Mr. Francis was made manager and chief inspector, carrying on the dual responsibilities until 1914, when the growth of the department led to the appointment of C. R. Summers as chief inspector.

Three generations of the Francis family have chosen careers with the Hartford Steam Boiler Inspection and Insurance Company. Manager Francis' father, Charles D. Francis, was for many years a member of the home office inspection force, and his son, A. P. Francis, is now assistant manager of the Atlanta department.

The Atlanta department serves owners of pressure vessels and power machinery in Alabama, Florida, Georgia, South Carolina, and parts of North Carolina and Tennessee.

A.S.M.E. Meets in Cincinnati, June 19 to 21

Taking advantage of the opportunities offered in the machine-tool district of Cincinnati, the A.S.M.E. is devoting four of the sessions of its 1935 Semi-Annual Meeting, to be held in that city June 19 to 21, to its Machine Shop Practice Division. Machine tools will be discussed at two of these sessions; power transmission and lubrication being the subjects for the others.

Sessions sponsored by the Fuels and Steam Power Division, and by the Materials Handling, Railroad, Iron and Steel, Management, Aeronautics, and Process Industries Divisions have been planned. The Committee on Education and Training for the Industries will also present some papers.

In connection with the Graphic Arts Research Bureau and the Lithographic Research Foundation, the A.S.M.E. Graphic Arts Division will take part in the special program of the Graphic Arts Conference, to be held at the University of Cincinnati.

Sheet Metal Foreman Examination

The United States Civil Service Commission has announced an open competitive examination for sheet metal foreman.

Applications for the position of Foreman and Layout Man, Sheet Metal Shop, Northeastern Penitentiary, Lewisburg, Pa., must be on file with the U. S. Civil Service Commission at Washington, D. C., not later than April 29, 1935.

The entrance salary is $2300 a year, subject to a deduction of 3½ percent toward a retirement annuity.

Applicants must have had at least 3 years of experience as foreman and shop layout man of a factory manufacturing sheet metal equipment, or of a department in a large factory engaged in such manufacture, including generally the classes of work specified in the duties given in the examination announcement; in addition, they must have had at least 2 years of experience in designing and drafting for the manufacture of sheet metal equipment; provided, that 5 years of employment in which supervisory, layout, and drafting experience have run *concurrently* will be accepted as meeting the full requirements for eligibility.

Full information may be obtained from the Secretary of the United States Civil Service Board of Examiners at the post office or customhouse in any city which has a post office of the first or the second class, or from the United States Civil Service Commission, Washington, D. C.

Steam Railway Accident Statistics December, 1934

The Interstate Commerce Commission's completed statistics of steam railway accidents for the month of December, now in preparation for the printer, will show:

Item	Month of December 1934	Month of December 1933	12 Months Ended with December 1934	12 Months Ended with December 1933
Number of train accidents:				
Total	532	545	6,023	5,623
(At highway grade crossings, included in total)	22	13	169	129
Number of casualties in train, train-service and non-train accidents:				
Trespassers:				
Killed	150	194	2,654	2,826
Injured	164	197	3,156	3,997
Passengers on trains:				
Killed	...	1	27	38
Injured	212	199	1,870	1,972
Employees on duty:				
Killed	50	57	526	500
Injured	1,478	1,396	16,990	15,583
All other nontrespassers:*				
Killed	189	179	1,672	1,655
Injured	752	654	6,615	5,942
Total—All Classes of persons:				
Killed	389	431	4,879	5,019
Injured	2,606	2,446	28,631	27,494

* Casualties to "other nontrespassers" happen chiefly at highway grade crossings. Total highway grade-crossing casualties *for all classes of persons, including both trespassers and nontrespassers,* were as follows:

Killed	177	171	1,554	1,511
Injured	525	451	4,300	3,697

Reading Iron Company Announces Changes

W. S. Shiffer, general manager of sales of the Reading Iron Company, announced recently that S. H. Blackwood, formerly assistant district sales representative in the New York territory had been made district sales representative in Southern territory with headquarters at 1104 Continental Building, Baltimore, Md. Mr. Blackwood takes the position held for many years by W. J. White, who recently resigned. W. N. Johnson has been appointed as salesman in the New York territory.

Boiler Maker and Plate Fabricator

VOLUME XXXV NUMBER 4

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Request for change of address should reach us on or before the 15th of the month preceding the issue with which it is to go into effect. It is difficult and often impossible, to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address, please be sure to send us your old address as well as the new one.

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EDITORIAL STAFF: H. H. Brown, Editor. L. S. Blodgett, Managing Editor

Contents

Baldwin Locomotive Works Reorganizing

The Baldwin Locomotive Works, Philadelphia, has filed a petition under the provisions of Section 77B of the Federal statutes providing for the reorganization of corporations. An order was entered by Judge Dickinson approving this petition as complying with the statutory provisions. This order provides that Baldwin may continue temporarily in possession of its properties with authority to continue to operate its business as heretofore.

This action affects the parent company only and does not affect the status of any of its subsidiaries, pursuant to the terms of the order. The business of the Baldwin Locomotive Works will be continued, for the present at least, without cessation of operations or change in operating conditions or business relations. This action has been made necessary through the reduction of the company's working capital to a place where it cannot meet its operating expenses and also its fixed charges. Plans are under way for the reorganization of the company's financial structure to reduce its fixed charges and to provide essential working capital.

Lukens Appoints a Director of Research

Erle G. Hill has joined Lukens Steel Company, Coatesville, Pa., as director of research. He was born in Santa Ana, Cal., in 1890 and studied mining and metallurgical engineering at the University of California. After graduation in 1913, he took graduate work at the University of California, Carnegie Institute of Technology and the University of Pittsburgh.

Mr. Hill's early work was as a mining engineer and metallurgist in the western states and in Mexico. In 1918, he became an instructor in mining and metallurgy at the Carnegie Institute of Technology, during which time he was also a member of the staff of the Pennsylvania Geological Survey. In 1920, he became an associate professor of metallurgy at the University of Pittsburgh, serving there for ten years, during which time he also functioned as consultant for various companies in mining and metallurgical fields. He resigned in 1930 to accept a research fellowship at the Mellon Institute of Industrial Research, remaining in that work until he joined Lukens Steel Company. He is a member of the American Institute of Mining and Metallurgical Engineers, American Society of Metals, American Society of Testing Materials and the Franklin Institute.

Trade Publications

Flexible Coupling.—The Lovejoy Tool Works, Chicago, has recently developed and is now producing a new type flexible coupling designated L-R Flexible Coupling type P, which is the subject of a descriptive sheet now being sent out by the company.

Steels Specifications Chart.—The official steel specifications of the Society of Automotive Engineers have been issued in folder form by Republic Steel Corporation, Massillon, O. This reprint by Republic is from the most recent revision of the list of standard S. A. E. alloy and carbon steels. The chart has been published with the permission of the Society of Automotive Engineers.

"Hydraulik" Accumulators.—A descriptive pamphlet on compressed air accumulators without pistons or floats, and hydraulic presses has been issued by Seamless Steel Equipment Corporation, New York. This company has recently taken over representation of the Hydraulik G. m. b. H. of Duisburg, Germany, builders of this type accumulator and hydraulic presses of all types and sizes.

Compressors.—Chicago Pneumatic Tool Company, Chicago, Ill., has issued a bulletin describing its newly designed horizontal, single-stage compressor, type T. These compressors are double-acting and water-cooled, arranged for belt and direct-connected motor drive for permanent or semi-permanent installations. They are used for compressing air and most commercial gases. Complete details, with numerous illustrations, explain the construction features of this type compressor.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on practical boiler shop problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given special permission to do so.

By George M. Davies

Computing Load on Locomotive Boiler Brace

Q.—Referring to the accompanying elevation and sections of a locomotive boiler, together with throat sheet braces, would you kindly explain the method of computing the load on these braces and also if same are satisfactory for 180 pounds working pressure? M. I. J.

A.—The sketches of the boiler, showing the application of the throat sheet braces, and the detail of the throat brace as submitted with the question are illustrated in Figs. 1 and 2.

The area to be supported by each of the throat sheet braces is shown in Fig. 3, these areas being determined in the following manner:

First determine the maximum allowable pitch of stays for the firebox tube sheet, from the formula:

$$P = \sqrt{\frac{c + T^2}{P}}$$

where:

P = maximum allowable working pressure pounds per square inch

T = thickness of plate in sixteenths of an inch

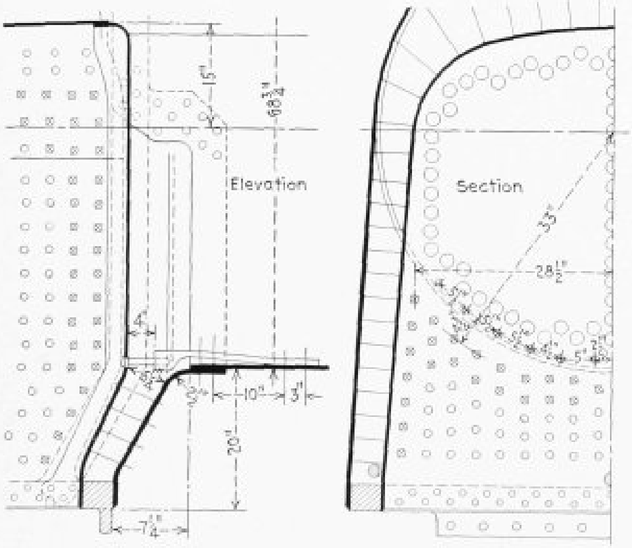


Fig. 1.—Application of throat sheet braces

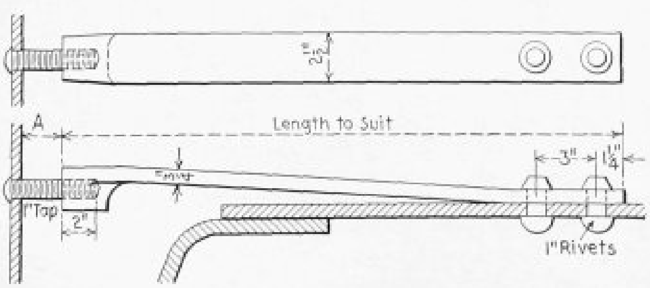


Fig. 2.—Detail of throat brace

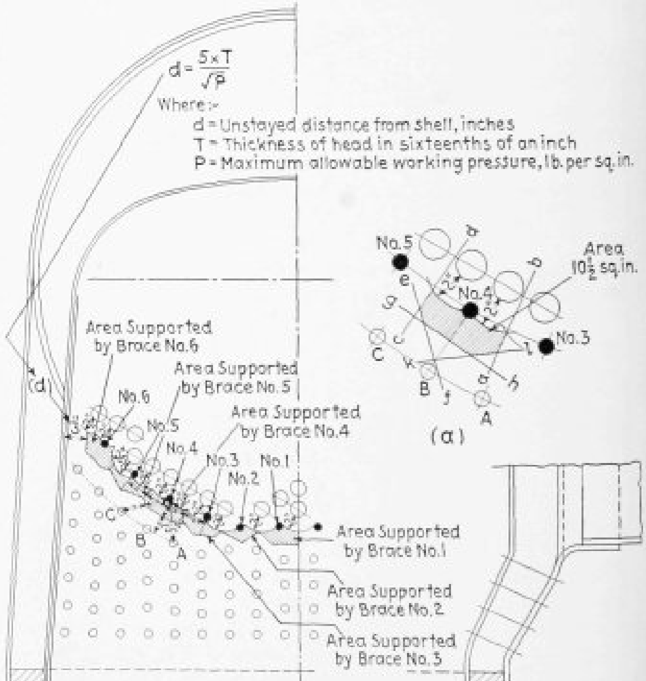


Fig. 3—Calculating area to be supported by each brace

p = maximum pitch, measured between straight lines passing through the center of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, inches

c = constant = 120 for stays less than twenty diameters long screwed through plates with ends riveted over.

Substituting in the formula:

$P = 180,\ T = 8,\ C = 120$

$$p = \sqrt{\frac{120 + (8)^2}{180}}$$

$$p = \sqrt{42.66}$$

$p = 6.5$ inches maximum allowable pitch of stays and staybolts in firebox tube sheet.

Having determined the maximum allowable pitch of stays and staybolts, check the stay and staybolt layout as shown in Fig. 3 to be sure that the pitch has not been exceeded.

The maximum pitch as measured on the layout, Fig. 3, is from staybolt *A* to brace No. 4. This pitch is 5¾ inches and is within the maximum allowable pitch calculated.

An examination of Fig. 3, indicates that brace No. 4 supports the greatest area, and is therefore used as an illustration of the method for determining the area supported by the stays.

Fig. 3(a) is an enlarged view of brace No. 4 with surrounding tubes and staybolts.

The area supported by brace No. 4 is determined in the following manner:

The permissible unstayed distance from the tubes is 2 inches; thus scribe arcs 2 inches away from the tubes as shown in Fig. 3(a).

Next connect the centers of brace No. 3 and brace No. 4, and No. 4 and No. 5. Divide these distances into two equal parts and erect perpendiculars to the lines at these points as *a-b* and *c-d*; then connect the centers of staybolts *A*, *B* and *C* with the stay No. 4. Divide these distances into two equal parts and erect perpendiculars to the lines at these points as *e-f*, *g-h*, *k-l*.

The area enclosed by these lines as shown in Fig. 3(a) is the area required to be supported by brace No. 4.

The area can be determined by measuring same with a planimeter or by laying out full size and computing same by dividing the area into small sections, computing each section separately and taking the sum of all the sections as the total area. The area to be stayed by brace No. 4 is 10.5 square inches.

The load carried by the brace will be

$$L = P \times A$$

where;

L = total load on brace in pounds
P = working pressure in lbs. per square inch
A = area supported by brace in square inch

$$L = 180 \times 10.5$$
$$L = 1890 \text{ pounds}$$

The required cross-sectional area equals the total load carried by the brace divided by the allowable stress for unwelded stays or braces which is 7500 pounds, for unwelded stays less than twenty diameters long screwed through plates with ends riveted over.

$\frac{1890}{7500} = 0.252$ square inch—required cross-sectional area of brace. The brace is checked against the required cross-sectional area as follows:

(1) The actual cross-sectional area of a 1-inch diameter stay as shown in Fig. 2, assuming same to have V-threads is:
Area root of thread 1 inch diameter stay with V-threads = 0.5751 square inch.
The brace is therefore satisfactory through the stay portion.

(2) The cross-sectional area of the rivets should be equal to 1¼ times the required cross-sectional area of the brace or
$0.252 \times 1.25 = 0.315$ square inch.
The cross-sectional area of the rivets is:
Diameter of rivet hole 1¹⁄₁₆ inches.
Area 1¹⁄₁₆-inch circle equals 0.8866 square inches.
$0.8866 \times 2 = 1.7732$ square inches; which is satisfactory.

(3) The body of the brace is 2.5×0.75 or 1.875 square inch; which is satisfactory.

(4) The net sectional area through the sides of the brace at the rivet holes shall be at least equal to 1¼ times the required cross-sectional area of the braces.
$0.252 \times 0.125 = 0.315$ square inch required.
Actual $(2.5 - 1.0625) \times 0.75 = 1.07$ square inches which is satisfactory.

The brace shown in Fig. 2 is therefore satisfactory to carry the load on brace No. 4 which carries the greatest load of all braces shown in Fig. 3. The other braces carrying a less load are therefore also satisfactory and the entire throat bracing is satisfactory for a working pressure of 180 pounds per square inch.

Allowable Pressure on Locomotive Boiler Wrapper Sheet

Q.—In your October, 1934, issue of your magazine under Questions and Answers you published the form for figuring the wrapper sheet of a locomotive type boiler under P-212 (b) of the 1930 A. S. M. E. Code. That paragraph reads as follows: The maximum allowed pressure of a stayed wrapper sheet of a locomotive type boiler should be determined by the two methods given above and by the method which follows and the minimum value shall be used. Could you give me or publish in your magazine the other two methods, P-212 (a) 1 and 2 illustrating by examples, and if the lowest efficiency is not on top center would you apply the method as shown in the October issue. Also, in figuring the first method it refers to P-199 for formula of flat plate. What do you use if the staying is unequal, say 4 inch centers and 6 inches between rows? I would appreciate your answer to these problems.—V. D. G.

A.—Par. P-212 (a) of the A. S. M. E. Code referred to in the question is as follows:

P-212 (a) The maximum allowable working pressure for any curved stayed surface subject to internal pressure shall be obtained by the two following methods, and the minimum value obtained shall be used.

First, the maximum allowable pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays or riveted longitudinal joint or other construction. To this pressure there shall be added the pressure secured by the formula for braced and stayed surfaces given in Par. P-199, using 70 for the value of C.

Second, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays or riveted longitudinal joint or other construction. To this pressure there shall be added the pressure corresponding to the strength of the stays or braces for the stresses given in Table P-8, each stay or brace being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay or brace.

Par. P-199 referred to in the first method of calculation of P-212 (a) is as follows:

P-199. The maximum allowable working pressure for various thicknesses of braced and stayed flat plates and those which by these Rules require staying as flat surfaces with braces or staybolts of uniform diameter symmetrically spaced, shall be calculated by the formula:

$$P = C \times \frac{T^2}{p^2}$$

where:

P = maximum allowable working pressure, pounds per square inch
T = thickness of plate in sixteenths of an inch

p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, inches

Table P-8 referred to in the second method of calculation of P-212 (a) is as follows:

TABLE P-8.—MAXIMUM ALLOWABLE STRESSES FOR STAYBOLTS AND STAYS OR BRACES

Description of staybolts and stays or braces	Stresses, pounds per square inch: For lengths between supports not exceeding 120 diameters	For lengths between supports exceeding 120 diameters
(a) Unwelded or flexible staybolts less than twenty diameters* long, screwed through plates with ends riveted over	7,500	....
(b) Hollow steel staybolts less than twenty diameters* long, screwed through plates with ends riveted over	8,000	....
(c) Unwelded stays or braces and unwelded portions of welded stays or braces	9,500	8,500
(d) Steel through stays or braces exceeding 1½ inches diameter*	10,400	9,000
(e) Welded portions of stays or braces	6,000	6,000

* Diameters taken at body of stay or brace.

Fig. 1 illustrates a typical locomotive firebox wrapper sheet layout with the necessary information for computing the maximum allowable working pressure in accordance with Par. P-212 (a).

Computing the maximum allowable working pressure for the wrapper sheet, at the front end, by the first method in Par. P-212 (a) we have

$$P = \frac{TS \times t \times E}{FS \times R}$$

where:

P = maximum allowable working pressure in pounds per square inch

TS = ultimate tensile strength of plate in pounds per square inch assume 55,000

t = thickness of wrapper sheet in inches from Fig. 1—9/16 inch

E = efficiency of longitudinal joint or of ligament between openings. From Fig. 1 the longitudinal pitch of the staybolts is 4 inches and using flexible staybolt sleeves 1 11/16 inches O. D.

$$E = \frac{4 - 1.6875}{4} = 57.8 \text{ percent}$$

FS = Factor of safety = 4.5 for locomotive boilers

R = Inside radius of wrapper sheet at front end, in inches, from Fig. 1—40¾ inches

Substituting in the formula, we have:

$$P = \frac{55{,}000 \times 0.5625 \times 0.578}{4.5 \times 40.75}$$

$$P = 97.5 \text{ pounds per square inch}$$

To this pressure add the pressure obtained by the formula given in Par. P-199 using 70 for the value of C

$$P = C \times \frac{T^2}{p^2}$$

where:

$C = 70$

$T = 9$, from Fig. 1—wrapper sheet 9/16 inch thick

$p = 8\frac{1}{8}$ from Fig. 1—between 7th and 8th row of staybolts

$$P = 70 \times \frac{9^2}{8.125^2}$$

$$P = 85.4 \text{ pounds}$$

The maximum allowable working pressure based on the first method would be

$$97.5 + 85.4 = 182.9 \text{ pounds}$$

Computing the maximum allowable working pressure for the wrapper sheet, at the front end, by the second method in Par. P-212 (a) we have:

Maximum allowable working pressure computed without allowing for holding pressure of the stays equals 97.5 pounds as computed in the first method.

To this pressure add the pressure corresponding to the strength of the staybolts for the stresses given in Table P-8.

Taking the seventh row of staybolts (marked Staybolt "A" in Fig. 1) as supporting the greatest area we have:

Area supported by staybolt "A":

4 1/16 + 3 11/16 = 7¾ inches

7¾ × 4 = 31 square inches area

The flexible staybolts used have the following characteristics:

Staybolts—1 inch diameter; 12—U. S. F. threaded end; 13/16 inch diameter body.

Cross-sectional area of body = 0.51849 square inch.

Cross-sectional area root of thread = 0.6245 square inch.

The staybolt has its least cross-sectional area through the body.

Area supported by one staybolt = 31—0.51849 = 30.48151 square inches.

From Table P-8 we find the maximum allowable stress for flexible staybolts to be 7500 pounds per square inch.

7500 × 0.51849 = 3888.675 pounds load carried by one staybolt.

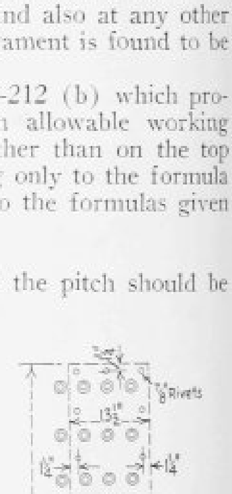
3888.675 ÷ 30.48151 = 127.5 pounds allowable pressure for staybolts. The maximum allowable working pressure based on the second method would be

$$97.5 + 127.5 = 225 \text{ pounds per square inch}$$

The strength of the wrapper sheet should be checked by both methods at the back end and also at any other place where the efficiency of the ligament is found to be below that already used.

I would interpret that part of P-212 (b) which provides for increasing the maximum allowable working pressure when same is obtained other than on the top center line of the boiler as applying only to the formula given in Par. P-212 (b) and not to the formulas given in Par. P-212 (a).

In the formula $P = C \times \frac{T^2}{p^2}$, p the pitch should be taken as the maximum pitch passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined. In the example given in the question p should be taken as 6 inches.



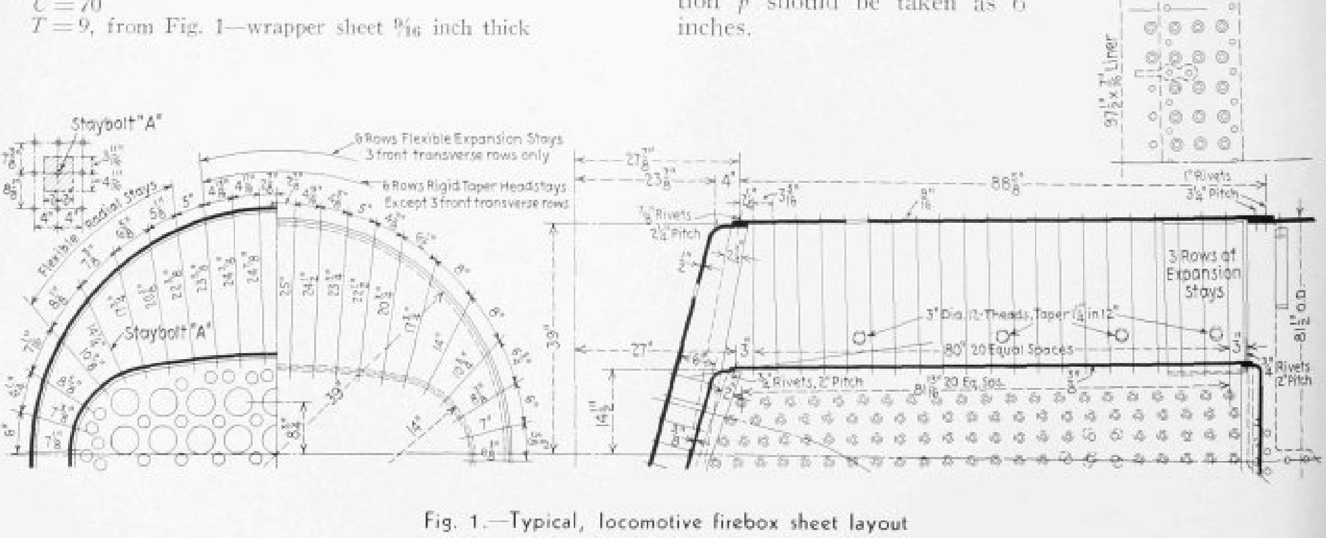


Fig. 1.—Typical, locomotive firebox sheet layout

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Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

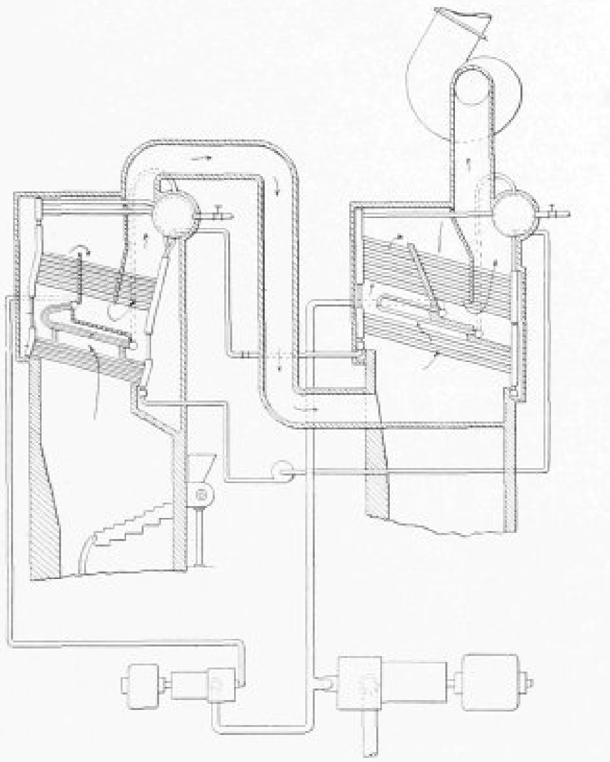
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

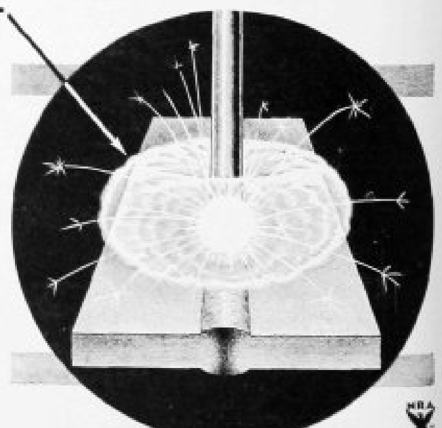
Compiled by Dwight B. Galt, Patent Attorney, 1372-1376 National Press Building, Washington, D. C. Readers wishing copies of patents or any further information regarding any patent described, should correspond directly with Mr. Galt.

1,860,363. STEAM GENERATOR. WALTER DOUGLAS LA MONT, OF LARCHMONT, NEW YORK, ASSIGNOR TO LA MONT CORPORATION, A CORPORATION OF NEW YORK.

Claim.—Apparatus for the generation of steam, comprising the combination with a steam generator of the water circulating type of at least



one set of auxiliary steam generating tubes, means for generating steam in the auxiliary steam generating tubes at a pressure different from that of the steam generator, said means including a connection through a suitable pressure transformer between the steam generator and the auxiliary generating tubes, and means for causing a part at least of the water from one of the steam generators to flow through said connection into the circulation of the other generator so as to be effective for causing circulation in said other generator. Twenty-one claims.



Boiler Maker and Plate Fabricator

NRA
CODE
GRAPHIC ARTS INDUSTRY

Steel Boiler Construction

During the first quarter of 1935, the boiler manufacturing industry experienced the best volume of business that it has for several years. According to reports of the Bureau of the Census, Department of Commerce, from the producers of 90 percent of the steel boilers of the country, there were 1043 steel boilers of all types built during this quarter, totaling 1,329,242 square feet of heating surface. This number compares with 755 boilers of 838,643 square feet during the first quarter of 1934 and 568 boilers of 591,594 square feet during the first quarter of 1933.

From a peak in March, however, of 418 units having a heating surface of 655,812 square feet, the industry has experienced a decline in business parallel to that in the heavy industries generally, mainly due to uncertainty induced by the wavering policy of the past few months in Washington. The prospects for extensive replacement and modernization of equipment in power plants and heating systems are extremely good. If business is allowed to develop normally and without Government interference for a while, the boiler manufacturing industry is certain to stage a fairly rapid recovery.

The annual meeting of the American Boiler Manufacturers' Association and Affiliated Industries will be held June 10 to 12 at The Lodge of Skytop Club, Skytop, Pa. By then the trend of heavy industry may be sufficiently developed for members of this industry to shape policies for sales promotion of their products. There is always somewhat of a lag between the construction industries and that of boiler manufacture. With Public Works Administration projects and building in general undergoing stimulation at the present time, there is a real possibility that definite recovery within the boiler industry will occur during the latter part of the year.

The Mechanical Associations and Their Future

The annual meetings of the so-called minor mechanical associations, which were tentatively scheduled for the early part of this month, were finally canceled—or, more properly speaking, were allowed to go by default because of lack of encouragement on the part of the higher officers. Finally they were eliminated by the letter from the vice-president in charge of operation of the Association of American Railroads, which was cited in the April Boiler Maker and Plate Fabricator.

Fortunately the Committee on Co-ordination of the Mechanical Conventions has not given up hope for the future of these organizations, including the Master Boiler Makers' Association, and is soliciting the support of the Association of American Railroads for the holding of a business meeting of the co-ordinated associations some time next fall. This group is also suggesting to the various associations that they keep their committees at work preparing for such a meeting.

Most of these associations have been dormant for such a long time that it will be a hard fight to revive their activities and get back the old spirit. The Mechanical Division, which will hold a two-day general meeting in June, can undoubtedly be a large factor in stimulating these associations, although the Division itself has not shown the same aggressiveness as have some associations in other departments, which, incidentally, are of no greater importance to the railroads than the mechanical organization. Undoubtedly, however, if the Mechanical Division puts up a strong fight for the minor associations, it will be a large factor in placing them back on their feet.

It is vital, if they expect to continue to exist, that the officers and members of these associations put up a strong and spirited fight for their continuance; otherwise they are quite likely to be lost by the wayside.

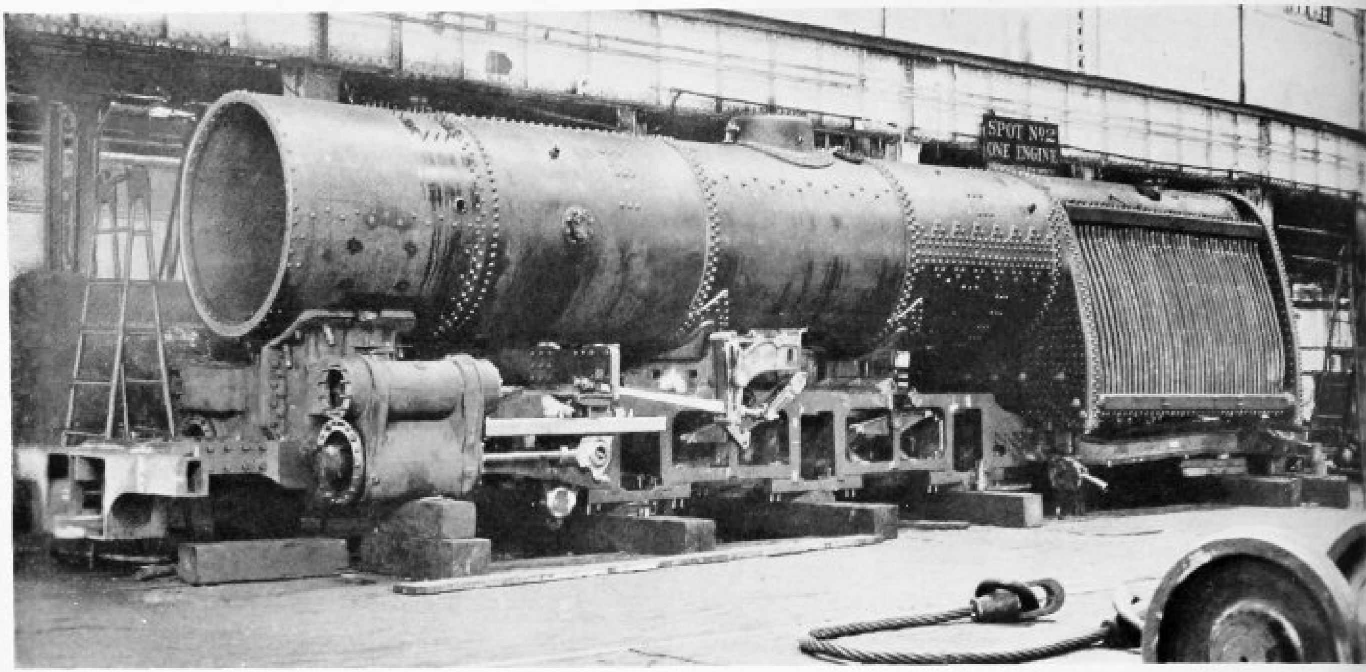
The events through which railroad mechanical officers have passed in recent years have been most discouraging and distressing, but it does seem that the time has now come when they must make a real fight to rebuild their associations. We need prophets and a lot of them, but backing them up we need fighters—men of courage and vision, who realize what it means to have associations of men, dealing with the practical affairs of the mechanical department, getting together in council to discuss how they can best meet the problems with which they are confronted, and to so improve the equipment and its operation that the railroads can successfully meet and overcome the subsidized competition of other types of carriers.

The National Board of Boiler Inspectors

Something over a year ago the National Board of Boiler and Pressure Vessel Inspectors staged the most successful meeting of its history in New York. As this issue of Boiler Maker and Plate Fabricator goes to press, the Tenth Annual Meeting of the board is underway in Chicago. The program of this meeting, which appears on page 120, demonstrates better than any laudatory comments the reason why this organization has developed a broad influence in the boiler and pressure vessel fields.

In the course of the four days in which sessions are being held practically every subject of current importance to the chief inspectors of the states and cities making up the membership will be discussed. Experts from every department of design and construction, as well as leading authorities in the inspection branch will explain developments that have taken place since the last meeting. Knowledge of materials constitutes so important a part of the inspector's equipment that this phase of the manufacturing industry is comprehensively treated.

The vast fund of information developed by the National Board in the form of papers and discussions at their Tenth Annual Meeting will be made available to readers of Boiler Maker and Plate Fabricator in coming issues.



Boiler for one of the new locomotives of the Baltimore & Ohio

Emerson watertube firebox feature of new

BALTIMORE & OHIO LOCOMOTIVES

The Baltimore & Ohio has designed and built at the Mount Clare shops, Baltimore, Md., two locomotives of radically new design which are to be used to haul trains of light-weight streamlined passenger cars on fast schedules. Two special trains of eight cars each are being provided, one constructed largely of Cor-Ten steel weighing approximately 390 tons, and the other in which aluminum alloys are employed weighing about 350 tons. One of the trains will be placed in service on the Alton between Chicago and St. Louis about July 1, while the other may later be operated between New York and Washington.

The smaller locomotive, which has a 4-4-4 wheel arrangement, road No. 1, class J-1, has been named *Lady Baltimore*. The larger locomotive, which has a 4-6-4 wheel arrangement, road No. 2, Class V-2, has been named *Lord Baltimore*. The first weighs 217,800 pounds, exclusive of the tender, and the second, 294,000 pounds. Both have 84-inch drivers. A striking feature of these locomotives is the boiler which embodies the Emerson watertube firebox and carries 350 pounds steam pressure.

The smaller locomotive is estimated to develop a maximum sustained cylinder horsepower of 1810 with a boiler estimated at 1990 horsepower, and the larger one a maximum of 2200 cylinder horsepower with a boiler estimated at 2660 horsepower, these calculations being made on the general basis of Cole's ratios.

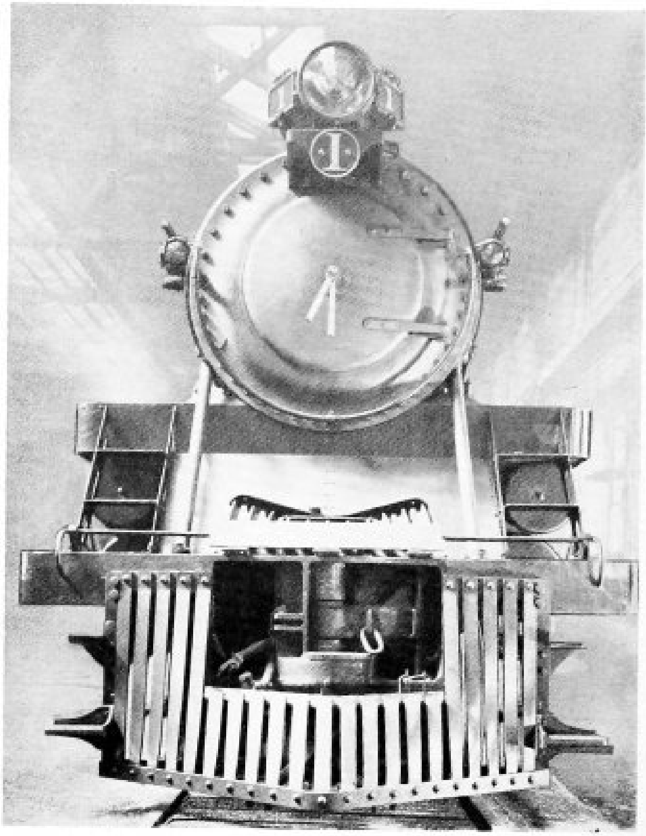
Both locomotives have hauled test trains of about 250 tons, which is approximately equal to the weight of trains consisting of six of the new light-weight coaches. When operating on schedules of about 60 miles per hour, and including regular express station stops as well as operating checks and speed restrictions, both have demonstrated their ability to meet schedule requirements with top speeds rarely exceeding 80 miles per hour. This result was possible because of the high rate of acceleration at medium and high speeds. The class J-1 locomotive, which was completed in September, 1934, has already been in service on several divisions of the Baltimore & Ohio System, and has made some exceptionally fast runs on the Chicago division. At 95 miles per hour it developed 1570 drawbar horsepower.

The boilers of both locomotives are designed for 350 pounds per square inch working pressure and are similar in construction to the boilers on the experimental locomotives of the 4-8-2 and 2-6-6-2 types described in The Boiler Maker, October, 1933. The barrels are of conventional type with 2¼-inch fire tubes and 5½-inch flues. At the back end the barrel terminates in a stayed water-leg with throat and back tube sheets which forms the front of the firebox. The back end of the firebox is also a stayed water-leg and in general construction resembles the ordinary backhead of a conventional boiler. The staybolts in the water-legs are of such length and location as to avoid the usual breakage zone.

Principal Dimensions and Weights of the Baltimore & Ohio High-Speed Locomotives

Builder	B. & O.	B. & O.
Name	Lady Baltimore	Lord Baltimore
Road number	1	2
Road class	J-1	V-2
Type	4-4-4	4-6-4
Service	Passenger	Passenger
Height to top of stack	13 ft. 4½ in.	14 ft. 4¾ in.
Width	10 ft. 3 in.	10 ft. 1¼ in.
Cylinders, diameter and stroke	17½ in. by 28 in.	19 in. by 28 in.
Valve gear, type	Walschaert	Walschaert
Valves, piston type:		
Size	10 in.	10 in.
Maximum travel	7 in.	7 in.
Cut-off in full gear, percent	75	75
Weights in working order:		
On drivers	99,800 lb.	156,000 lb.
On front truck	40,000 lb.	45,000 lb.
On trailing truck	78,000 lb.	93,000 lb.
Total engine	217,800 lb.	294,000 lb.
Tender	170,000 lb.	199,800 lb.
Wheel bases:		
Driving	7 ft. 5 in	14 ft. 10 in.
Total engine	35 ft. 5½ in.	42 ft. 10½ in.
Total engine and tender	71 ft. 4½ in.	81 ft. 6½ in.
Wheels, diam. outside tires:		
Driving	84 in.	84 in.
Front truck	36 in.	36 in.
Trailing	36 in.	36 in.
Boiler:		
Type	Comb. fire and water-tube	Comb. fire and water-tube
Steam pressure	350 lb.	350 lb.
Fuel	Soft coal	Soft coal
Stoker	B. & O.	Standard (Lower)
Diameter, first ring outside	62 in.	72 in.
Firebox, length and width	159 in. by 78 in.	159 in. by 78 in.
Grate dimensions	114 in. by 78 in.	114 in. by 78 in.
Tubes, number and diameter	77—2¼ in.	120—2¼ in.
Flues, number and diameter	18—5½ in.	27—5½ in.
Length over tube sheets	17 ft. 9 in.	25 ft. 0 in.
Grate area	61.75 sq.ft.	61.75 sq.ft.
Heating surfaces:		
Firebox, total	523 sq.ft.	612 sq.ft
Tubes and flues	1,257 sq.ft.	2,727 sq.ft.
Total evaporative	1,780 sq.ft.	3,339 sq.ft.
Superheating	415 sq.ft.	880 sq.ft.
Comb. evap. and superheat	2,195 sq.ft.	4,219 sq.ft.
Tender:		
Style	Water bottom	Water bottom
Fuel capacity	14 tons	16 tons
Water capacity	8,000 gal.	10,000 gal.
Trucks	4-wheel	4-wheel
General data, estimated:		
Rated tractive force engine	28,000 lb.	34,000 lb.
Rated tractive force, with booster	35,000 lb.	41,000 lb.
Weight on drivers ÷ tractive force	3.56	4.59

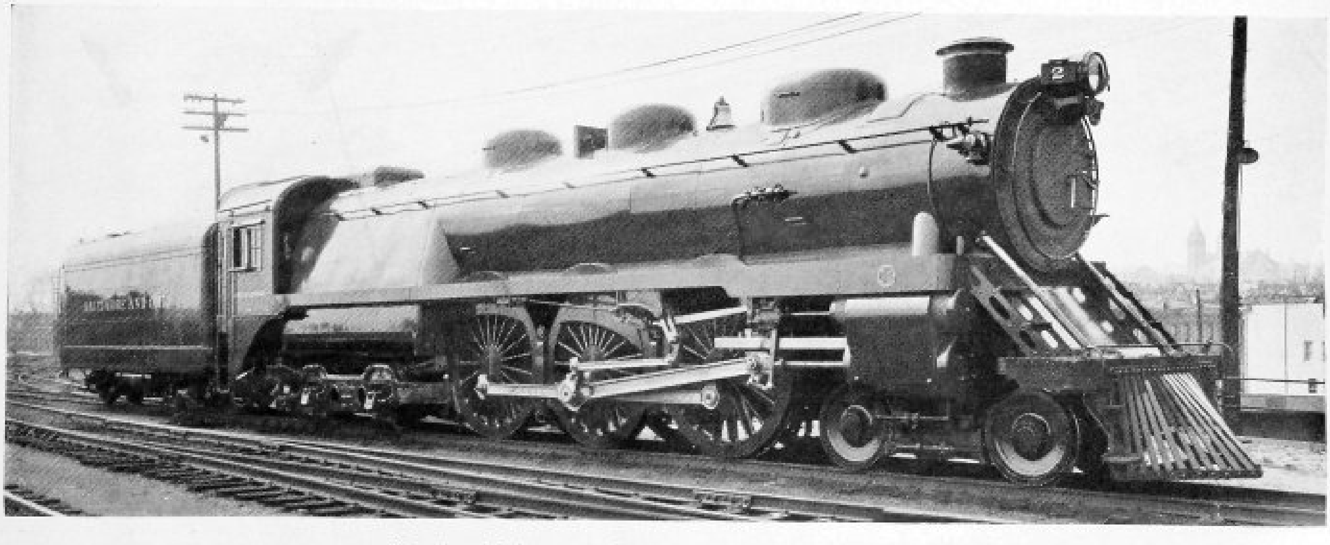
Above the firebox there is a single longitudinal drum, 36 inches in outside diameter, which projects into the upper part of the boiler shell to which it is connected by means of a flanged hip sheet. The drum extends forward



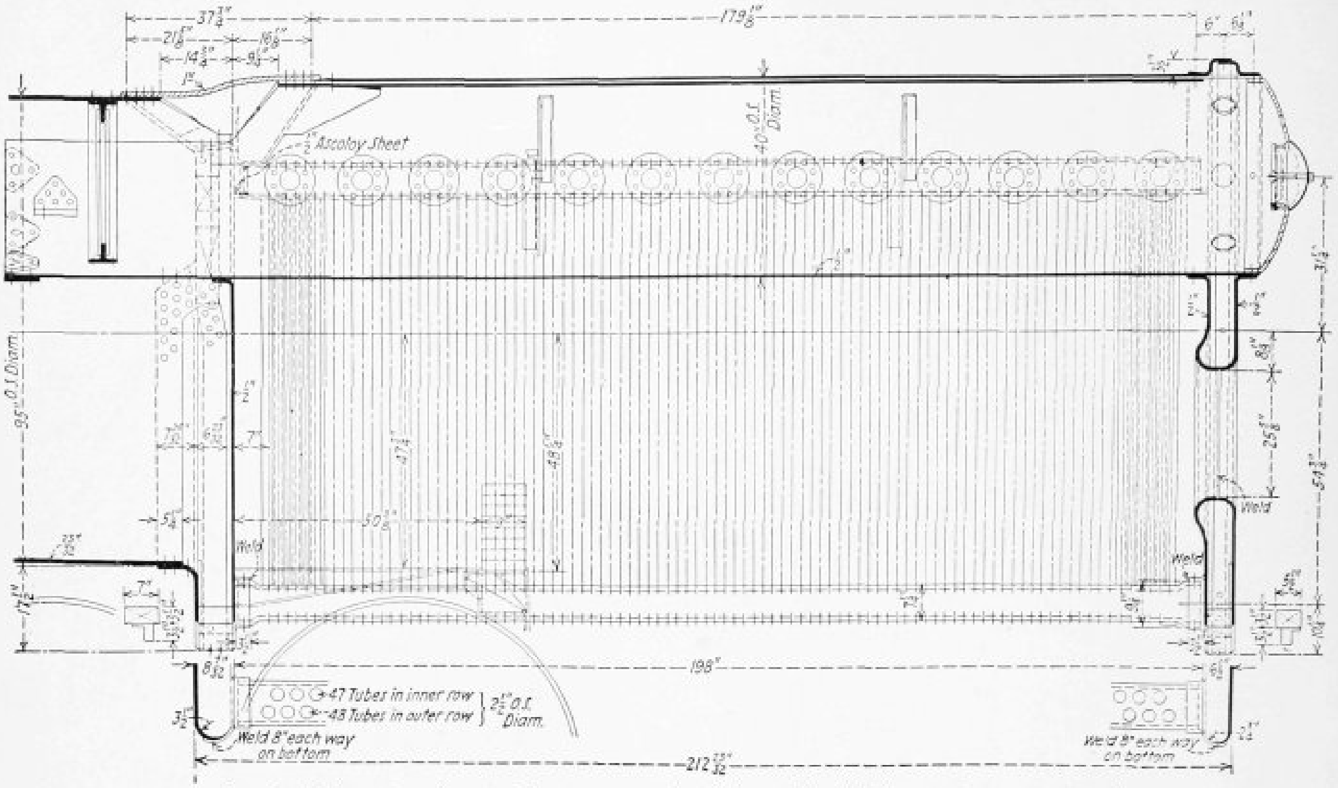
The front end of the new locomotives follows British practice in its door arrangement

into the shell of the boiler 4 feet 8 inches beyond the back tube sheet. The upper portion of this extension is cut away, leaving the lower part in the form of a trough from which the top circulation is delivered to the barrel of the boiler. At the rear end the drum is carried through the back water-leg, with which it communicates by means of circulating ports, and terminates in a bulged head. A standard manhole through the backhead of the drum is provided for convenience of inspection.

The two water-legs are connected at the bottom by headers, one on each side. These are of seamless steel and rectangular in section except at the ends, where the



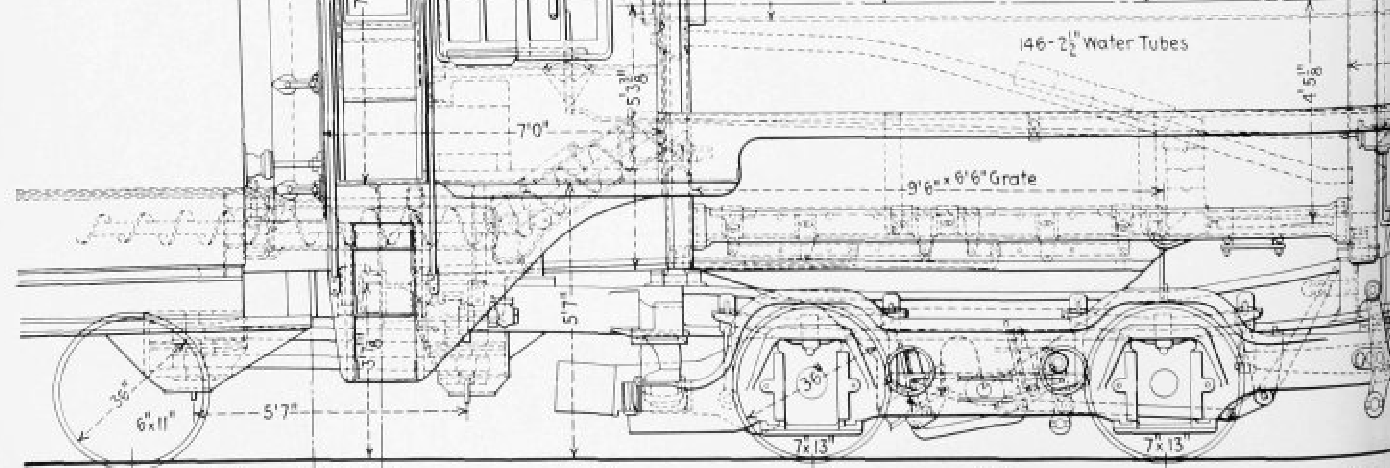
The "Lord Baltimore," Class V-2, 4—6—4-type locomotive



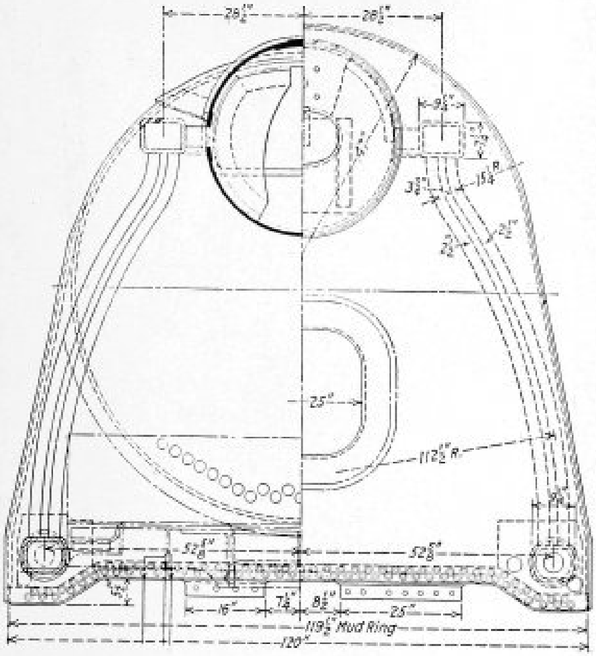
Longitudinal section of typical Emerson watertube firebox with which locomotives are equipped

section changes to a circular form for attachment to the flanged openings in the headers. These headers provide for the circulation between the two water-legs and form the bottom side frame of the firebox. Top headers of similar cross-section but closed at the ends extend along each side of the drum, to which they are connected by means of horizontal nipples, rolled in. On each side between the upper and lower headers are two staggered rows of watertubes, 2¼ inches in outside diameter, which are rolled into both headers.

Opposite each watertube in the top and bottom headers there is a plug opening through which the tubes are rolled. The bottom plugs are not removed during washouts. The plugs in the top headers are fitted with coarse threads and are easily removed. Through these openings washing and turbining operations are performed.



Elevation drawing of Baltimore & Ohio



Cross section of Emerson watertube firebox

Engine house time for washing the watertube firebox is said not to exceed that necessary for the conventional staybolt type.

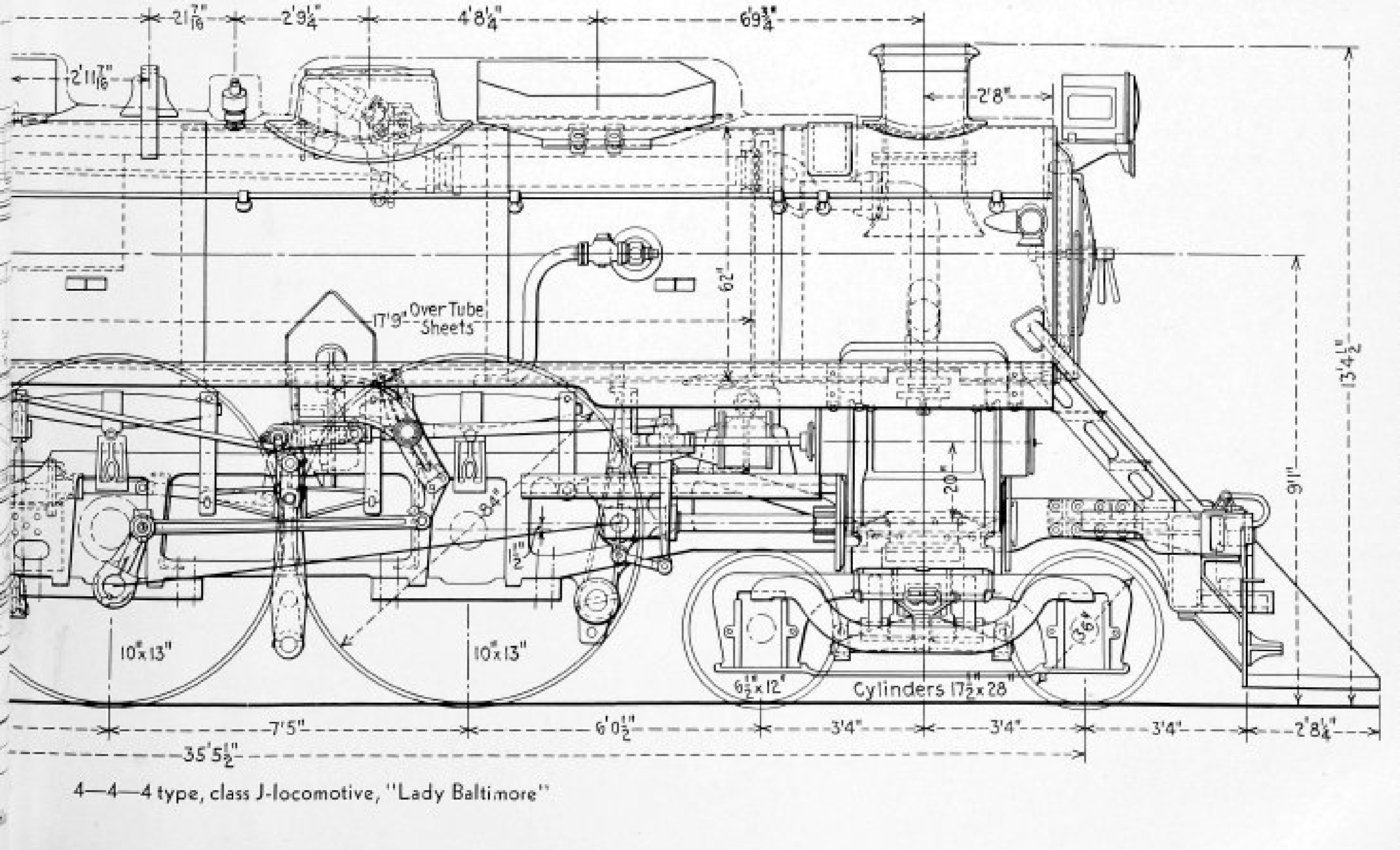
The side watertubes, with their top and bottom headers, the drums, and the front and back water-legs, enclose a firebox substantially rectangular in outline which is of stayless construction except for the water legs. The firebox is enveloped and made airtight with a firebrick covering, magnesia lagging and a steel jacket.

The first Emerson watertube firebox was applied on a B. & O. locomotive in 1927 and since that date others have been applied, both to new and existing boiler shells. Throughout the wide experience with this type of firebox in service on all parts of the B. & O. they have proved more satisfactory than the conventional type. Their initial cost is no greater than that of staybolt fireboxes of similar size and they eliminate crown and side-sheet staybolts. At each washout the scale in the fire tubes is completely removed by turbining, thus effecting a high average heat transfer and improved thermal efficiency.

The fireboxes on both locomotives are 159 inches long by 78 inches wide and are fitted with five arch tubes. The length of the grate is reduced to 114 inches by a fire wall extending up to the arch tubes. This wall and the Security arch carried on the tubes in effect divide the firebox volume into a firebox proper with 61.75 square feet of grate area and a 36-inch combustion chamber. Because of the larger diameter of the boiler shell the average length of the watertubes in the class V-2 locomotive is 6 feet 4 inches against an average length of 5 feet 3 inches for the class J-1. This results in a total firebox heating surface of 523 square feet in the class J-1 and 612 square feet in the class V-2. The fireboxes are fitted with B. & O. standard table type grates which are shaken by hand.

Locomotives of both designs are equipped with stokers. That on the 4-4-4 type locomotive is of railroad design, while that on the 4-6-4 type is the Lower type. Both are of the backhead type with steam-jet coal distribution, the conveyors being operated by two-cylinder reciprocating type engines mounted on the tender.

The superheaters, built by the railroad, have headers fabricated from rolled plate by welding and units rolled into the headers. There are 18 units in the smaller boiler and 27 in the larger. The boilers are fed by Hancock non-lifting injectors designed for operation with high-pressure steam. The check valves are located on the side of the boiler near the front tube sheet.



4—4—4 type, class J-locomotive, "Lady Baltimore"

A noticeable feature of these locomotives is the front-end door from which the usual multiplicity of clamp bolts is absent. The doors are secured by a single lock and clamp similar to those applied in British practice. Two yokes which span the inside of the door opening at right angles are slotted to receive the tee-head of the clamp bolt which is turned by the handle next to the door. The door is then drawn tight by the lock nut operated by the outer handle. The door can thus be quickly opened and closed. No difficulty has been encountered in maintaining a tight metal-to-metal joint at the edge of such doors so long as the diameter is kept within suitable limits.

The tender for the 4-4-4 type locomotive has a capacity for 14 tons of coal and 8000 gallons of water; that for the 4-6-4 type locomotive a capacity for 16 tons of coal and 10,000 gallons of water. Both are fitted with water scoops. Both tenders are mounted on four-wheel trucks with 6-inch by 11-inch journals and 36-inch rolled-steel wheels. All tender trucks are fitted with Fafnir roller bearings.

The locomotives are finished in royal blue without striping, except for the polished metal rods and motion work. The lettering is in gold. The principal dimensions and weights of both locomotives are included in an accompanying table.

Boiler Inspectors Hold Annual Meeting

The Tenth Annual Meeting of the National Board of Boiler and Pressure Vessel Inspectors was held on May 14, 15, 16 and 17 at the Stevens Hotel, Chicago.

The great changes that are rapidly being brought about by the development of new materials, as well as new methods of design and fabrication, were largely the basis on which the program was arranged. The papers were unusually interesting and particularly important to the boiler and pressure vessel industry at this time.

Program of National Board Meeting

TUESDAY MORNING

10:00 A. M. Call to order and address by W. H. Furman, chairman of National Board.

10:10 A. M. Address—Honorable Edward J. Kelly, Mayor of Chicago.

10:20 A. M. Address—C. F. Weigel, representing American Boiler Manufacturers' Association and Affiliated Industries.

10:30 A. M. Address—Dr. D. S. Jacobus, past president, American Welding Society.

10:40 A. M. Vision of the Expansion of the National Board. C. O. Myers.

11:00 A. M. Statistical Analysis of Boiler Accidents as a Means of Improving Experience. J. P. H. deWindt.

11:20 A. M. The Inspection and Care of Oil Refinery Pressure Vessels. F. L. Newcomb.

12:00 Noon. General Practices of the Canadian Provincial Inspection Service. N. S. Walsh.

12:15 P. M. Administration of the Boiler Inspection Law in the Province of Ontario, Canada. E. T. Urquhart.

TUESDAY AFTERNOON

1:40 P. M. Call to order by W. H. Furman, chairman of National Board.

1:41 P. M. Introduction of G. Gearon as chairman of the afternoon session.

1:45 P. M. Application of Code Rules to Flat Heads and Flanges. D. B. Wesstrom.

2:30 P. M. Application of Code Rules to Vessels Subject to External Pressure. W. D. Halsey.

3:00 P. M. Adjourn.

3:15 P. M. Executive session of National Board (members only).

5:00 P. M. Adjourn.

WEDNESDAY MORNING

9:15 A. M. Call to order by W. H. Furman, chairman of National Board.

9:16 A. M. Introduction of H. H. Mills as chairman of the morning session.

9:20 A. M. Construction and Strength Characteristics of Laminated Wall Pressure Vessel Construction. T. M. Jasper.

9:50 A. M. Test of Physical Properties of Welds. R. K. Hopkins.

10:30 A. M. A. S. M. E. Interpretations for Shop and Field Practice. Dr. D. S. Jacobus.

10:50 A. M. Prospective Methods of Minimizing Hazards in the Operation of Refrigerating Systems. L. S. Morse.

11:45 A. M. Use of Alloy Steel for Temperatures over 800 Degrees in the Construction of Boiler Drums, Superheaters and Steam Pipes. G. K. Herzog.

12:15 P. M. Prevention of Furnace Explosions in Boiler Installations. E. R. Fish.

12:30 P. M. Water Fall Failures. D. L. Royer.

WEDNESDAY AFTERNOON

2:30 P. M. Visit to shop of Lasker Boiler and Engineering Company.

THURSDAY MORNING

9:15 A. M. Call to order by W. H. Furman, chairman of National Board.

9:16 A. M. Introduction of M. A. Edgar, chairman of the morning session.

9:20 A. M. Bent Tube Boiler Failures. J. P. Morrison.

9:45 A. M. The Latest Developments in Non-Destructive Examinations of Welded Joints. J. C. Hodge.

10:25 A. M. Development of New Ferrous Materials for Use in the Construction of High-Pressure Boilers and Pressure Vessels. L. P. McAllister.

11:00 A. M. Metallurgy of Welding. A. J. Moses.

THURSDAY AFTERNOON

1:30 P. M. Call to order by W. H. Furman, chairman of National Board.

1:31 P. M. Introduction of C. E. McGinnis, chairman of afternoon session.

1:35 P. M. Experience with the Operation of Boilers Operated at Pressures in Excess of 1000 Pounds.

2:00 P. M. Welding of High-Pressure Steam Pipe. J. R. Tanner.

3:00 P. M. General discussion.

5:30 P. M. Adjourn.

FRIDAY MORNING

9:30 A. M. Call to order of executive session of National Board (members only) by W. H. Furman, chairman of National Board.

9:40 A. M. Reading of minutes of previous meeting.

9:45 A. M. Report of secretary-treasurer.

10:00 A. M. Reports of standing committees. Reports of special committees. Communications. Unfinished business. New business.

1:00 P. M. Adjourn.

Stress relieving fusion welded

PRESSURE VESSELS

By Dr. D. S. Jacobus*

There is no subject bearing on the construction of fusion welded pressure vessels on which there is such a wide variation of opinion as on the conditions which make it necessary to stress relieve the joints. The American Society of Mechanical Engineers' Boiler Code requires that the stresses be relieved in certain cases by heating uniformly to at least 1100 degrees F., and up to 1200 degrees F. or higher if this can be done without distortion, and holding the vessels at that temperature for a period of time proportioned on the basis of at least one hour per inch of thickness. The Code covers the welding of plain carbon steels in which the carbon content does not exceed 0.35 percent. All-welded drums for power boilers and all pressure vessels employed in the most dangerous service are required to be stress relieved, but the Unfired Pressure Vessel Code sanctions the use of quite a wide range of fusion welded vessels without stress relief.

The temperature specified for stress relieving the welds does not refine the grain structure. In vessels made of alloy steel or in which the carbon limit exceeds that specified in the Code, it is necessary in many cases to refine the grain adjacent the welding by heating the vessels to above the critical temperature after welding. The remarks which follow apply to the stress relief of vessels, constructed of plain carbon steel in accordance with the rules of the A.S.M.E. Code, where the carbon content does not exceed 0.35 percent and may not apply to vessels constructed of other grades of steel.

The A.S.M.E. Unfired Pressure Vessel Code requires unfired pressure vessels which are to be used under the most exacting service conditions to be stress relieved and others for a limited field of service to be stress relieved, when the shell thickness for a given diameter exceeds a certain figure. Vessels of the latter class are required to be stress relieved where both the wall thickness is greater than 0.58 inch and the shell diameter less than 20 inches, and for all other wall thicknesses and shell diameters where the ratio of the diameter to the cube of the shell thickness is less than 100, and in all cases where the shell thickness is over 1½ inches.

The A.S.M.E. Unfired Pressure Vessel Code sanctions the use of unfired pressure vessels of the latter class for storing gases other than those of a lethal nature. Where water or other liquid is present in the vessel the pressure for a vessel that may be used without stress relief is limited to 400 pounds per square inch, and the temperature to 300 degrees F. The object of these limitations where the vessels contain liquids is to insure safety for types of vessels where the energy developed in the case of an explosion by the heated liquid has led to disastrous results.

The A.S.M.E. Code is more liberal in its stress relief requirements than any other code that I know of; for example, the specifications of the Bureau of Engineering of the United States Navy call for stress relieving all fusion welded pressure vessels, and the Tentative Requirements of Lloyd's Register of Shipping for Fusion Welded Vessels Intended for Land Purposes call for heat treating all vessels subject to internal steam pressures above 50 pounds per square inch, and other vessels, depending on the service for which the vessels are intended.

One of the objects of the rule given in the A.S.M.E. Boiler Code was to exempt certain vessels from the requirements of stress relief where it would be impossible to stress relieve the vessels. The vessels in mind were those built in the field having large diameters, say 30 feet or more, where it would be impossible to stress relieve the vessels as a whole and where there would be more flexibility than in a smaller vessel of the same plate thickness.

The rule exempting certain unfired pressure vessels from stress relief which was finally embodied in the Unfired Pressure Vessel Code was prepared jointly by the American Welding Society and the Boiler Code Committee. It was published before adoption with a request that criticisms or suggestions be submitted to the Boiler Code Committee. No criticisms or suggestions were received before including the rule in the Unfired Pressure Vessel Code, whereas there has been considerable discussion as to the exactness of the rule since its inclusion and the Boiler Code Committee has been requested to provide a more liberal rule.

Many investigations are in progress and much has been published on the strains and the corresponding stresses due to welding. It has been shown that welding a seam in a pressure vessel may produce elongations in the plate adjacent and at right angles to the weld, which will be two or more times as great as that required to produce a stress equal to the yield strength of the material. It has also been shown that the residual strains after the welding, both at right angles and parallel to the weld, may be in the neighborhood of those corresponding to the yield strength of the plate. It is well known that in fusion welding a pressure vessel it will at times rupture due to the strains produced by the welding, before the application of the hydrostatic test in the shop, all of which shows that the strains due to the fusion welding are of great magnitude. The question arises as to the effect of these strains should the vessel be placed in service without stress relief.

There is a feeling on the part of some that if a vessel is placed in service after being subjected to the usual hydrostatic tests that the stresses will gradually diminish due to the creeping of the material and safety will result through the readjustment of the stresses, provided the

* President, American Welding Society. From address on "Standards and Codes for Fusion Welding," presented at meeting of local sections of the American Welding Society, the American Society of Mechanical Engineers and the American Society for Metals, Detroit, Mich., April 17.

welds are sound and the weld metal of as uniform and as good quality as the plate.

Vessels tested by subjecting them to pulsating pressures have ruptured in the metal of the plate parallel to the weld at lower stresses than correspond to the strength of the material. It has been shown that this action may come through the stresses adjacent to the weld produced by the welding, as these stresses added to the hoop stress produced by the hydrostatic pressure may correspond to or exceed the endurance limit of the material. For certain types of service, therefore, there would seem to be no question but that it is well to stress relieve all fusion welded vessels.

A most important feature that must be considered in deciding whether a vessel should be stress relieved is the chance that the weld will not be as uniform and strong as the parent plate. If portions of the welded joint are not thoroughly fused, experience has shown that intermittent stresses due to variations in temperature or pressure will lead to cracks starting at the unfused portions and extending to an extent that may result in danger. Stress raisers of the sort due to imperfections in the weld are something that must be given most serious consideration and in case of a doubt those responsible for the formulation of safety codes naturally lean toward conservative rules.

The results secured in long service are the best measure of safety. It is difficult, however, to formulate rules based on the results secured in service where the art is advancing as rapidly as in the case of fusion welding and where defects may be developed after many years of use. Again, the stresses depend in a great measure on the method used in welding, and many variables are involved. We must not be misled through the rapid advances that have been made in the last few years into thinking that we know all about fusion welding. As I have said on other occasions, I do not believe we have proceeded over 25 percent of our way and it is certainly much better to advance carefully rather than to make mistakes for which we may be sorry.

All that I have said bears on fusion welded pressure vessels. The question naturally arises as to the use of fusion welding in other fields, such as in building, bridge and ship construction, where it would be impossible to stress relieve most of the joints. Great progress has been made in this type of welding and the record has been exceptionally clean in regard to failures in service. We therefore should not close our minds to providing more liberal rules for the stress relief of unfired pressure vessels if reliable information is secured which will warrant this being done with safety.

Bursting tests of vessels under hydrostatic pressure made in the ordinary way do not give data on which to base a rule for stress relief, as the residual stresses due to the welding have little or no effect on the bursting strength, whereas tests under intermittent pressures are especially valuable for the purpose. Such tests were proposed a long time ago by the American Welding Society and the Boiler Code Committee in working up a series of tests to be made at the Bureau of Standards in Washington. The tests were designated at the time as "breathing tests" in which the vessels were to be subjected to pressures alternating from about zero to 1½ times the allowable working pressure. These suggested tests were not made at the Bureau of Standards but The Babcock & Wilcox Company made tests along these lines under the supervision of Professor H. F. Moore. These tests did much in establishing the reliability of fusion welding and they are now regarded as accelerated service tests. Tests of the sort should be sufficiently inclusive as a few tests may not solve the problem.

Local stress relieving such as heating the area around a nozzle may set up objectionably high stresses in the shell of a vessel adjacent to or around the part that has been stress relieved. Where a vessel is stress relieved in two heats on account of it being longer than can be placed in the stress relieving furnace, there also may be objectionable stresses should the temperature gradient be too high in the portion between the heated and cooled part of the shell. This feature in stress relieving a vessel in two heats was provided for in the preparation of the Joint A.P.I.-A.S.M.E. Code for Unfired Pressure Vessels for Petroleum Liquids and Gases, which includes the requirement that the temperature gradient for the part in question shall not exceed 200 degrees F. per foot along the shell.

There are so many features of stress relief that have not been settled that some users of pressure vessels require all vessels to be stress relieved when the wall thickness is, say, ¾ inch, or over, even though no stress relief is demanded by the A.S.M.E. Code.

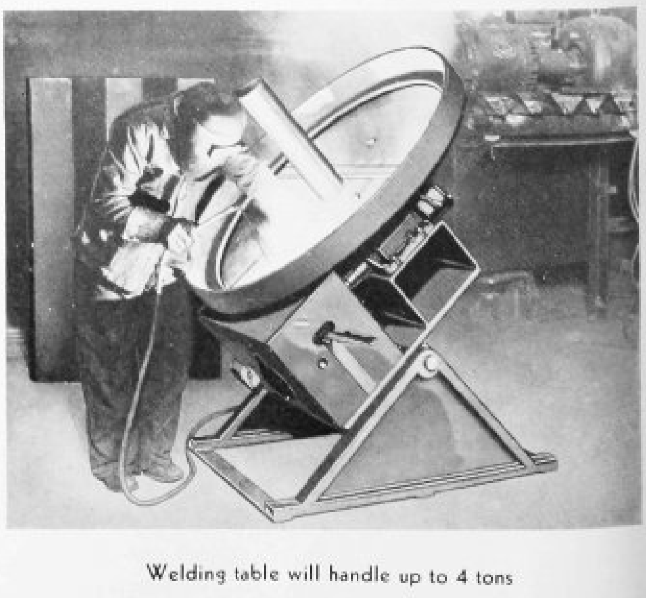
My own company (Babcock & Wilcox) has conducted researches at great expense to investigate the strains produced in fusion welding, which we will publish on completion, which convinced us that to secure maximum reliability and safety all vessels should be stress relieved after welding. In our own practice we usually stress relieve all vessels even though some are exempted from stress relief by the A.S.M.E. Code.

We have a lot to learn on this subject and while we should be looking forward to the possibility of using more liberal rules, we should make sure not to proceed unless reliable scientific data and facts show that the revised rules will be safe.

New Fixture Cuts Welding Time

A new type welding fixture with an inclined turntable arrangement for easier handling of circular pieces has been recently perfected by the Harnischfeger Corporation, Milwaukee.

To enable the operator to weld continuously in a downward position, the turntable is equipped with an electrical rotating mechanism with gear shift and variable speed motor control. Speed can be accurately regulated from 3 to 18 inches per minute in either direction at the circumference of the 42-inch table. Thus, for example,



Welding table will handle up to 4 tons

in welding a circular piece, the operator may hold the rod in a steady position as the work passes beneath it at the desired speed. The turntable can be tilted from one side of the base to the other or held in a horizontal position. Recently, fabricating time on a huge gear was reduced from 32 to 13 hours when sixty-five ⅜-inch rods were deposited in two hours.

Radium for Industrial Inspection

By J. F. Springer

X-Rays have been widely used in industry for quite a period. The United States Government has specified them as the means of inspecting the 400,000 linear feet of fusion welding of plate steel at Boulder Dam. But X-rays are limited, practically, to about 3-inch thicknesses of ferrous metals. From that point on the gamma rays of radium are the photographic agent upon which testing experts will generally have to rely. It is a matter of importance, then, as to where we are to get our gamma rays. Cost enters the picture, naturally. At present there are three sources.

(1) The gas emanation. This, at certain hospitals, is daily pumped from the parent radium salt, ordinarily in solution, and kept sealed in small glass bulbs. If you can get the hospital to let you have a bulb when not otherwise in use, then you have here a practical source of gamma rays.

(2) Mesothorium is also a source. It may be obtained as a by-product when monazite sand is worked for the purpose of recovering thorium.

(3) Commercial radium salt. Formerly, the states of Utah and Colorado, in the United States, were the principal sources of radium. Now, it appears that the Upper Katanga District of the Belgian Congo, in Africa, constitutes the chief area from which we obtain radium. But Canada seems to be coming on the horizon at the present moment.

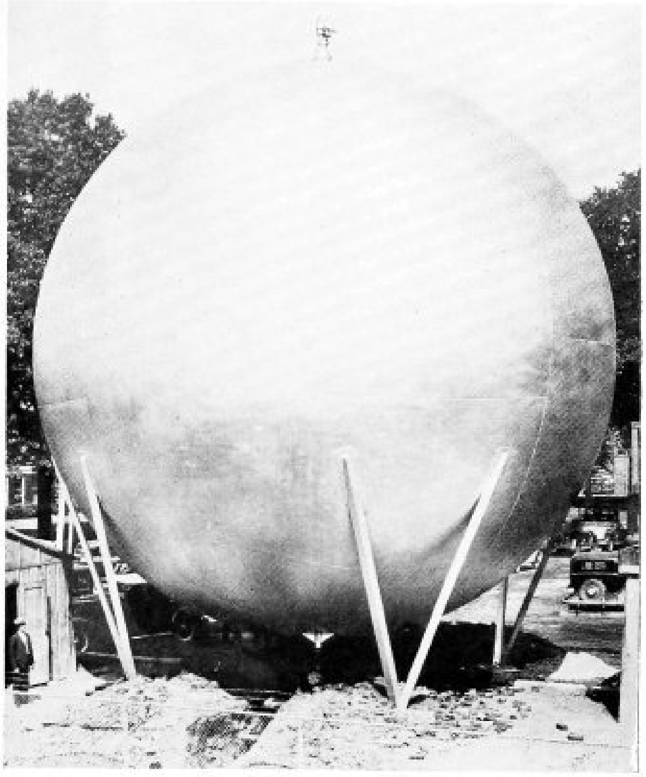
Hospitals must have radium. Industry would like to have a share, at some reasonable price. Some castings and forgings must be inspected, whatever the cost. Happily, gamma rays go forth in all directions, so that if we can arrange the objects properly, we can often get a multiplicity of inspections at moderate expense per item.

Radium is tremendously dangerous, when handled without due precautions. However, a safe technique has been worked out. In America, at any rate. And, perhaps elsewhere.

Tests Show No Leaks Arc-Welded Sphere

Electric arc welding was used in the construction of a 36-foot steel sphere, designed and erected by the Chicago Bridge and Iron Works at the General Electric Company's plant on East 152nd Street, Cleveland, and no leaks whatever showed up in subsequent tests.

This sphere, known by its trade name as a "Hortonsphere," is used to contain natural gas, and its purpose is to maintain pressure and British thermol unit content constant at all times. Thirty-six feet in diameter, the sphere has a volume of 24,400 cubic feet, but at its normal working pressure of 29 pounds per square inch, its storage capacity is an additional 50,000 cubic feet.



Hortonsphere, 36 feet in diameter

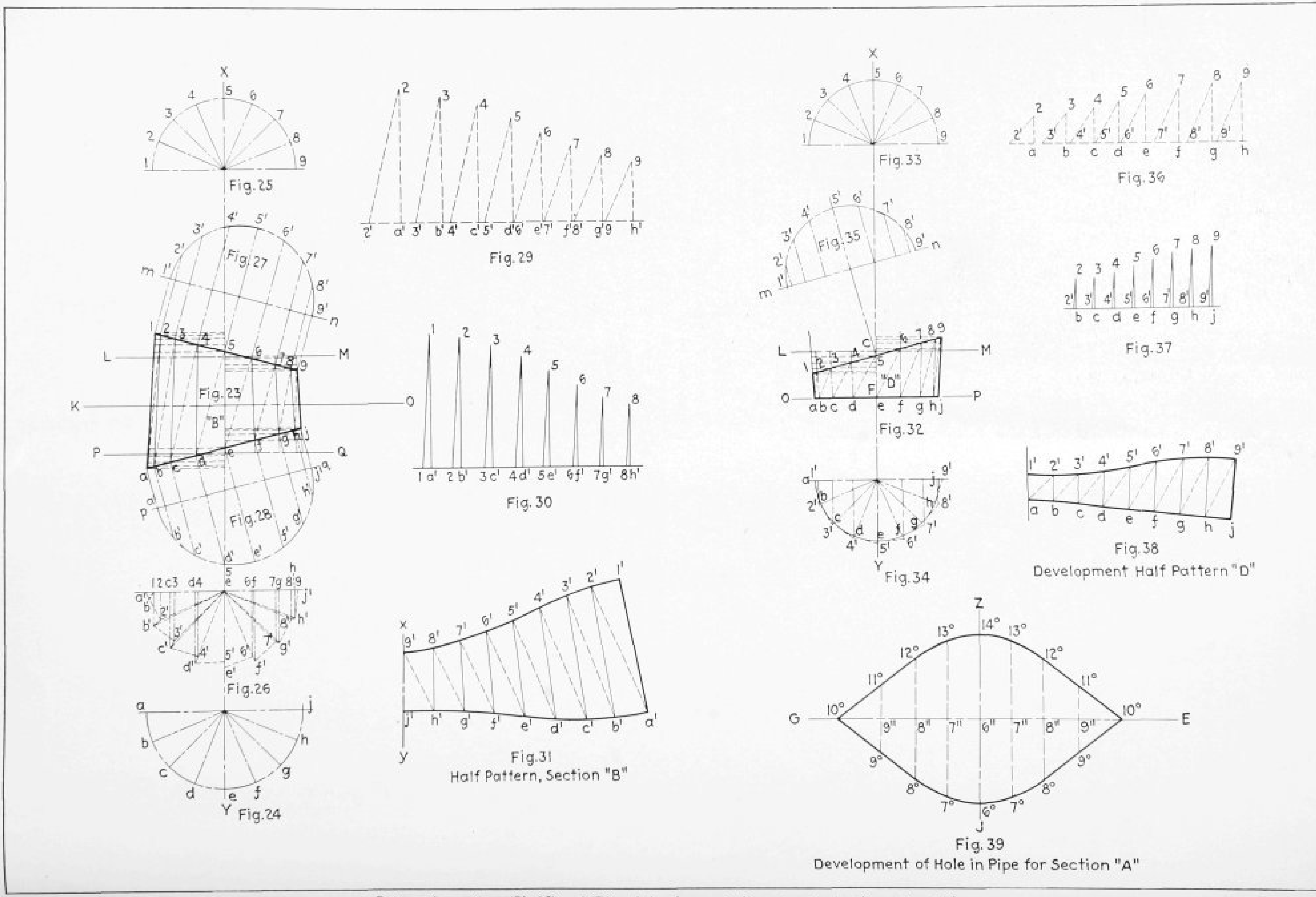
In construction, the steel was cut to size and formed in the shop, hauled to the job, hoisted into position, and welded in place. Two General Electric, 400-ampere, single-operator welding generators were used to produce the 800 linear feet of welding required in the erection of the sphere, the steel walls of which are approximately 5/16 inch thick.

Following completion, the sphere was tested in two different ways for possible leaks. In the first, the conventional soapy water test was used, and in the second test, a pressure of 38 pounds per square inch was put on the sphere and held for 48 hours. A recording pressure gage on the sphere recorded pressure throughout this test, and a record of temperatures was kept in order that pressure changes due to changes in temperature might be taken into account. As stated above, neither test showed the slightest trace of a leak.

Inspections Emphasized by British Board

After investigating an explosion of a jacketed process vessel, the British Board of Trade recently took occasion to emphasize the need not only of adequate safety devices for such pressure vessels but of periodic inspections by men qualified for that work. In reporting the result of the investigation *Vulcan* quotes the Board as asserting that the plant where the explosion occurred "failed in the duty encumbent on it of seeing that the jacketed pan was properly equipped with the necessary safety appliances, and was periodically inspected by qualified persons."

The accident resulted in the death of one person and the serious scalding of another. It was caused by a corrosion leak which permitted steam from the jacket to build up pressure underneath an inner pan not intended to withstand such pressure. The inner pan blew out and escaping steam and water injured attendants.



Patterns for sections (B), (C) and (D) and development of opening in pipe for section (A)

PRACTICAL PLATE DEVELOPMENT—III

Tapered Elbow Connection*

By George M. Davies

Patterns for Sections (B) and (C)

The patterns for sections (B) and (C) are developed in the same manner, therefore the method is explained for Section (B) only. Section (C) is developed in the same manner, the only difference being in the diameters of the sections.

Draw a vertical line *X-Y* running through Figs. 23, 24, 25, 26, 27 and 28 as shown. Across this draw a horizontal line, as *O-K*, Fig. 23, which represents the line *O-K*, Fig. 14. On the line *X-Y*, from the line *O-K*, step off the distances *a-2* and *2-b*, Fig. 14, and through these points draw the horizontal lines *P-Q* and *L-M*. Then on the vertical line *X-Y*, as in Fig. 24, describe a half circle which is the same diameter as the circle struck from the center (*a*), Fig. 14. Again, as in Fig. 25, describe another half circle the same diameter as that struck from center (*b*), Fig. 14. Divide both these circles into eight equal parts as you did in Fig. 17.

Number the points in Fig. 25 from *1* to *9* as shown, and the points in Fig. 24 *a* to *j* as shown.

Project the points *a* to *j*, Fig. 24, upward onto the line *P-Q* and the points *1* to *9* on Fig. 25 down onto the line *L-M*. Then draw the lines *a-1* and *j-9* by connecting the outside points on the lines *L-M* and *P-Q* and on these slanting lines set off the following distances: From the lines *O-K*, Fig. 14, take the distance *w-m*, Fig. 14, and set downward from the line *O-K*, Fig. 23. Then take the distance *w-n*, Fig. 14, and set it upward from the line *O-K*, Fig. 23. Take the distance *r-p*, Fig. 14, and set it downward from *O-K*, Fig. 23. Then take the distance *r-t*, Fig. 14, and set it upward from *O-K*, Fig. 23.

Connect the points *1* to *9* and *a* to *j* with slanting lines, thus producing the miter or joint lines.

Next project the points from the lines *P-Q* and *L-M* downward and upward by connecting lines onto the lines *1-9* and *a-j*, establishing the points *a, b, c, d, e, f, g, h, j* on *a-j*, and the points *1, 2, 3, 4, 5, 6, 7, 8, 9* on the line *1-9*.

Then as in Fig. 26 draw a horizontal line *1-9*, project down the points *a, b, c, d, e, f, g, h, j*, also points *1, 2, 3, 4, 5, 6, 7, 8, 9* cutting the line *1-9* as shown, and at the same time draw the vertical lines from these points. Again, in Fig. 23, draw the horizontal dotted lines through the points *a, b, c, d, e, f, g, h, j* and *1, 2, 3, 4, 5, 6, 7, 8, 9* to the surface lines *1-a* and *j-9*.

Then with the compasses take the length of the dotted line which runs through the point *b*, Fig. 23, and with the intersection of the line *X-Y* and *1-9*, Fig. 26, as a center, cut the line *b* at *b′*, Fig. 26. Again, take the length of the dotted line which runs through the point *c*, Fig. 23, and from the same center cut the line *c* at *c′*; continue this procedure to *h′*.

Take the length of the dotted line which runs through the point *2*, Fig. 23, and from the same center, cut the line *2*, Fig. 26, at *2′*. Then take the length of the dotted line which runs through point *3*, Fig. 23, and from the same center cut the line *3*, Fig. 26, at *3′*. Continue this procedure to *8′*. Then connect these points with lines as follows: *a′-2′, 2′-b′, b′-3′, 3′-c′, c′-4′, 4′-d′, d′-5′, 5′-e′, e′-6′, 6′-f′, f′-7′, 7′-g′ g′-8′ 8′-h′, h′-9, 9-j′*.

These distances are the bases of the triangles in Figs. 30 and 31.

Then from the points *1* to *9*, Fig. 23, draw lines at right angles to *1-9* cutting and extending past the line *m-n*, Fig. 27. From *m-n* on the line projected from the point *2*, Fig. 23, step off a distance equal to *2-2′*, Fig. 26, locating the point *2′*, Fig. 27. In like manner locate the points *2′, 3′, 4′, 5′, 6′, 7′, 8′*, Fig. 27.

From the points *a* to *j*, Fig. 23, draw lines at right angles to *a-j*, cutting and extending past the line *p-q*, Fig. 28. From *p-q* on the line projected down from the point *b*, Fig. 23, step off a distance equal to *b-b′*, Fig. 26, locating the point *b′*, Fig. 28. In like manner locate points *c′, d′, e′, f′, g′, h′* and *j′*, thus completing the profile of each end of the section.

To form the triangles, Fig. 29, draw a horizontal line and on this line erect the perpendiculars *a′-2, b′-3, c′-4, d′-5, e′-6, f′-7, g′-8* and *h′-9* equal to the vertical distance between the points *a-2, b-3, c-4, d-5, e-6, f-7, g-8* and *h-9*, Fig. 23, respectively. The bases *a′-2′, b′-3′, c′-4′*, etc., to *h′-9* are taken equal to their corresponding lengths as shown in Fig. 26. The hypotenuses of these right angle triangles are the true lengths of the dotted surface lines in Fig. 23.

Then on the horizontal lines in Fig. 30, erect perpendiculars *a′-1, b′-2, c′-3*, etc., to *h′-8* equal to the vertical distance between the points *a-1, b-2, c-3*, etc., to *h-8*, Fig. 23, respectively. The bases *a′-1, b′-2, c′-3* to *h′-8* are taken equal to *a′-1, b′-2′, c′-3′* to *h′-8′*, Fig. 26, respectively. The hypotenuses of these right angled triangles are the true lengths of the solid surface lines in Fig. 23.

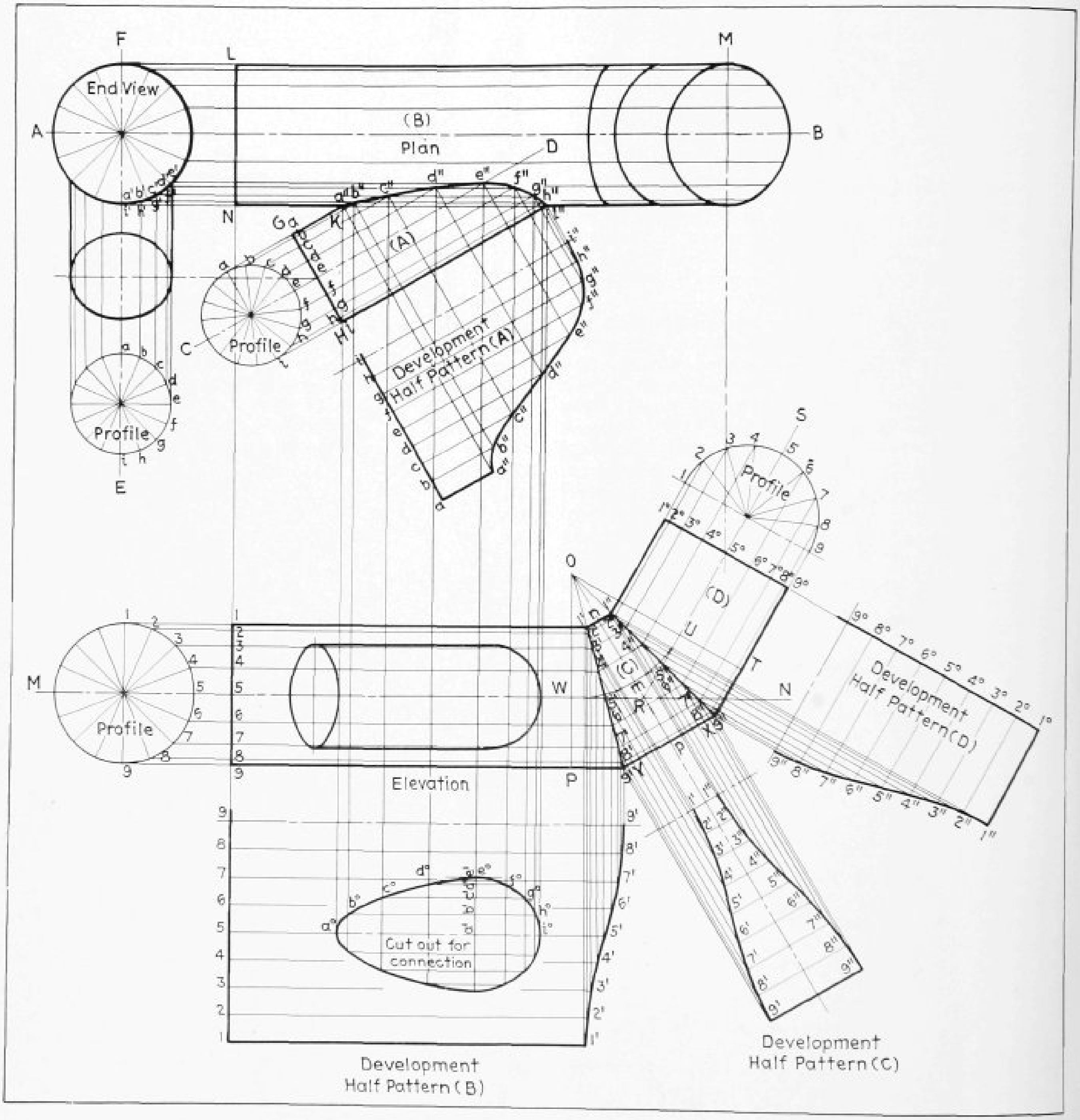
To Lay Out the Pattern Section (B)

The seam for this pattern is along the line *m-n*, Fig. 14, and for this reason the development is started along the line *9-j* as the center line of the pattern.

For the section (*C*) where the seam is on the short side, as shown in Fig. 14, the center line of the pattern will be taken along the long side of the section.

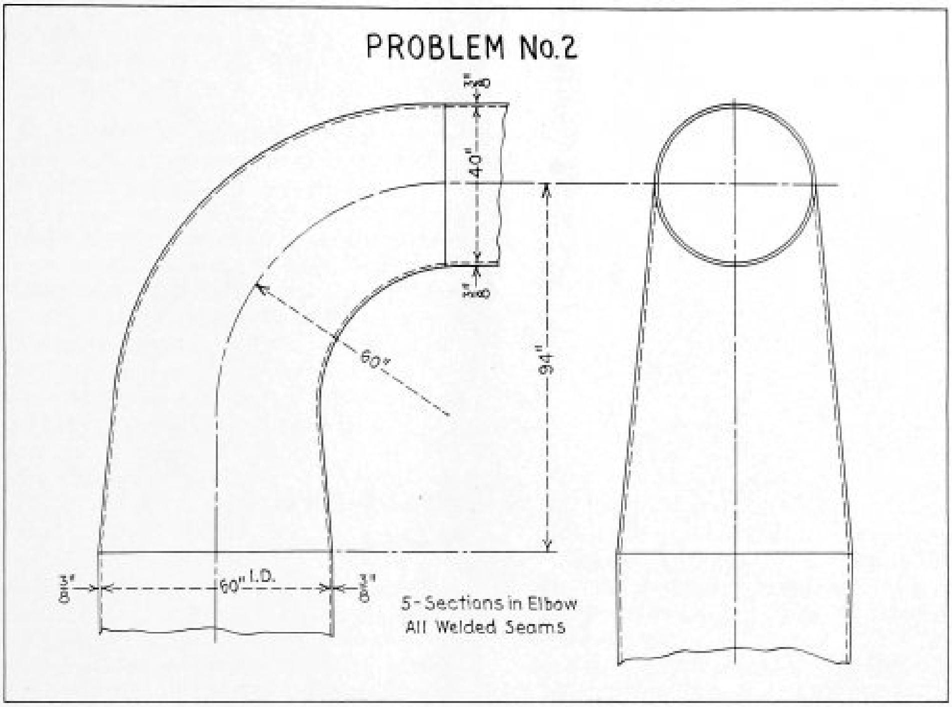
* Second part of the layout problem which commenced on page 105 of the April issue.

Problem No. 1—Correct Layout



On page 62 of the March issue "Practice Problem No. 1" was published for readers to lay out, applying the principles explained in the first instalment of this series on "Practical Plate Development." If any reader experiences difficulty in following the method of laying out this problem or requires further explanation on any part of the layout, after checking his solution carefully, he is invited to submit his questions to Mr. Davies through this office for help in clearing up the difficulty

Problem No. 2—For Readers to Lay Out



Practice Problem No. 2, is intended as an application of the principles of development employed in the "Taper Elbow Connection" published on page 105 of the April issue and completed in this issue. The correct solution will appear in connection with this series of articles on "Practical Plate Development," in the July issue. At that time readers who have attempted to lay out the above problem but experience difficulty can check their work or write in for further explanation

Draw the vertical line *x-y*, Fig. 31, on this set off the distance *j'-9'*, equal to *j-9*, Fig. 23. Then with *j'*, Fig. 31, as a center and with the dividers set equal to *j'-h'*, Fig. 28, scribe an arc, then with *9'* as a center and with the trams set equal to *9-9*, Fig. 29, scribe an arc cutting the arc just drawn locating the point *h'*, Fig. 31. Then with *9'*, Fig. 31 as a center and with the dividers set equal to *9'-8'*, Fig. 27, scribe an arc, then with *h'*, Fig. 31, as a center and with the trams set equal to *8-8*, Fig. 30, scribe an arc, cutting the arc just drawn, locating the point *8'*, Fig. 31. Then with *h'*, Fig. 31, as a center and with the dividers set equal to *h'-g'*, Fig. 28, scribe an arc; then with *8'*, Fig. 31, as a center and with the trams set equal to *8-8'*, Fig. 29, scribe an arc cutting the arc just drawn locating the point *g'*, Fig. 32. Then with *8'*, Fig. 31, as a center and with the dividers set equal to *8'-7'*, Fig. 27, scribe an arc, then with *g'*, Fig. 31, as a center and with the trams set equal to *7-7*, Fig. 30, as a radius scribe an arc cutting the arc just drawn locating the point *7'*, Fig. 31. Continue in this manner until all the hypotenuses in Figs. 29 and 30 are used together with the profile distances from Figs. 27 and 28, completing the half pattern as above.

Pattern for Section (D)

The development of the pattern for section (D) is shown in Figs. 32 to 38 inclusive.

Draw a vertical line *X-Y* running through Figs. 32, 33, 34 and 35 as shown. Across this draw a horizontal line, as *O-P*, Fig. 32, which represents the line *O-P*, Fig. 14. On the line *X-Y* from the line *O-P* step off the distance *F-C* equal to *F-C*, Fig. 14, and through this point draw the horizontal line *L-M*. Then on the vertical line *X-Y* as in Fig. 33 describe a half circle which is the same diameter as the circle struck from the center *C* Fig. 14. Again as in Fig. 34 describe another half circle whose diameter is equal to *P-Q*, Fig. 14. Divide both the circles into eight equal parts.

Number the points in Fig. 33 from *1* to *9* and the points in Fig. 34 from *a* to *j* as shown.

Project the points *a* to *j*, Fig. 34, upward onto the line *O-P* and the points *1* to *9* on Fig. 33 down onto the line *L-M*. Then draw lines *a-1* and *j-9* by connecting the outside points on the lines *L-M* and *O-P*. On these slanting lines set off the following distances: From the line *O-P*, Fig. 14, take the distance *P-y* and set it off on *j-9* from *O-P* in Fig. 32, locating the point *9*, Fig.

32. From the line *O-P* Fig. 14, take the distance *Q-z*, and set it off on *a-1* from *O-P*, Fig. 32 locating the point *1*, Fig. 32.

Connect the points *1-9* with a slanting line, thus producing the miter line.

The development from here on is very similar to that of the section (*B*) and by following the points through the various drawings in the same manner as for Section (*B*) the pattern for the half section (*D*) is completed.

ASSEMBLING THE PIPE

The patterns shown do not make any provision for welding the seams. The practice is to bevel the edges of the plates and to provide a gap between the plates after they are rolled for making the welds. Allowance should be made in the length and width of the plates and edges of the developed plates should be machined for the type of weld required.

DEVELOPMENT OF HOLE IN PIPE FOR CONNECTION (A)

Draw a horizontal line as *G-E*, Fig. 39, and at right angles to it draw the line *J-Z*. On *G-E* each side of the line *J-Z* space off the distances *6″-7″*, *7″-8″*, *8″-9″*, *9″-10°* equal to the distances *6″-7″*, *7″-8″*, *8″-9″*, *9″-10*, Fig. 13 as shown.

Then from point *6″*, Fig. 39, step off above *G-E* a distance equal to the vertical distance between the line *G-E* and the point *14°* in Fig. 14, locating the point *14°*, Fig. 39. Then from point *6″*, Fig. 39, step off below *G-E* a distance equal to the vertical distance between the line *G-E* and the point *6°* in Fig. 14, locating the point *6°*, Fig. 39.

Then from the points *7″*, Fig. 39, step off above *G-E* a distance equal to the vertical distance between the line *G-E* and the point *13°*, Fig. 14, locating the points *13°* in Fig. 39. Then from the points *7″*, Fig. 39, step off below *G-E* a distance equal to the vertical distance between the line *G-E* and the point *7°*, Fig. 14, locating the points *7°* in Fig. 39. Continue in this manner until all the points to *10°* on each side of *J-Z* are located. Connect the points *6°* to *10°* to *14°* on each side of *J-Z* completing the pattern of the cut-out in the pipe for section (A).

(To be continued)

Work of the A. S. M. E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information on the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th Street, New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published.

Following are records of the interpretations of this Committee formulated at the meeting of March 15, 1935, and approved by the Council.

CASE NO. 798.—(*Interpretation of Par. H-81*)

Inquiry: Par. H-81 of the Code refers to "unsupported joints" which are fusion-welded. Are the joints, when welded-in staybolts are attached to the plate as provided for in Par. H-83, considered "unsupported joints" as contemplated by Par. H-81, and do boilers fabricated in that way require shop inspection?

Reply: It is the opinion of the Committee that where staybolts in heating boilers are attached solely by welding the intent of Par. H-81 requires inspection by an authorized inspector during construction.

CASE NO. 803.—(*Interpretation of Par. P-214*)

Inquiry: Is it necessary, under the Code rules for staying of heads of firetube boilers, to apply stays to the segment of the head of an h.r.t. boiler when the maximum radial distance from the top row of the tubes to the shell, less the 2-inch exemption above the top row of tubes and less the exemption *d* next to the shell, does not exceed the allowable staybolt pitch of Table P-9 for the particular head thickness and working pressure?

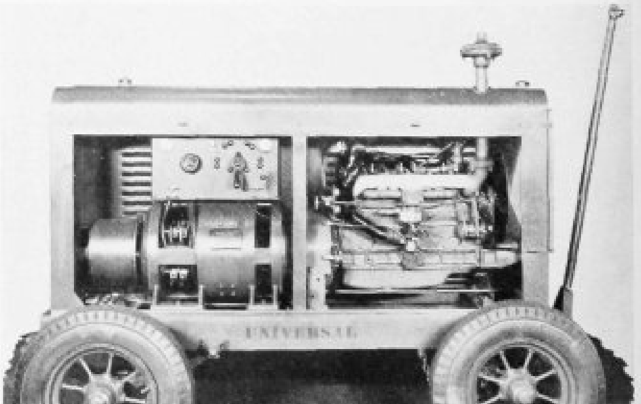
Reply: Par. P-214 of the Code indicates the areas to be stayed when staying is required. The rules in Par. P-216 determine if staying is required.

Staid-Arc Welders

Universal Staid-Arc welders, recently announced by Universal Power Corporation, Cleveland, as ready in the electric motor-generator type construction, are now also available in the gasoline engine driven types both portable and stationary.

The generator used utilizes the same stabilizing construction as that on Universal Staid-Arc motor-generator sets to deliver a staid smooth arc of high man hour welding efficiency. Generator output controls include a four-point current adjustment switch with convenient hand grip handle, plus a rheostatic voltage control which permits close welding heat settings totaling some six hundred steps. The control panel is of the ebony asbestos type mounting in addition to the control handles, a zero center Weston voltmeter indicating polarity, a zero center Weston ammeter, a polarity reversing switch and the welding output studs with heavy wing nut terminals.

The engines are of the sturdy Chrysler Industrial type of six-cylinder vibration free construction equipped with either battery ignition and electric starting equipment or with magneto ignition and hand cranking.



Universal welding generator unit

Double Strength Steel

*By Howard L. Miller**

The present condition of our railroads with their pressing demands for decreased operating costs is more critical now than it has ever been before in the history of transportation.

Two of the most important factors in the high cost of transportation are the tremendous weight of equipment as compared to paying load, and the rapid deterioration of equipment due to continual exposure to the elements, with resultant rusting and corrosion.

The experiments which have been made recently in using steels of special analysis, aluminum alloys, etc., indicate that railroad men are actively seeking some way to improve the position of the railroads by decreasing weight as well as by increasing performance.

The contribution of Republic Steel Corporation to this vital and pressing need has been the development of a copper-nickel-molybdenum steel which offers a combination of high strength, ductility and resistance to atmospheric corrosion. Republic Double Strength steel is a result of several years of special research based on many more years of experience in the production of copper-bearing steel and copper-molybdenum alloy iron.

The effectiveness of this combination in increasing corrosion-resistance has been thoroughly demonstrated both in service and in officially conducted tests. Double Strength steel shows similar characteristics, since it is of the same type. It is significant that this steel shows an exceedingly tight oxide skin under exposure to the most severe industrial atmosphere, and for this reason is particularly advantageous in railroad equipment used in carrying coal and other corrosion-promoting products.

Double Strength steel is the first analysis, showing as high a copper content, to be placed on a commercial basis in rolled products. It will be watched with considerable interest by the metallurgical world in general. The physical properties of the two grades as shown below can be increased 15,000 to 20,000 pounds per square inch by tempering sheets at 900 to 1000 degrees F., for about one hour of temperature. The commercial value of these higher properties is somewhat problematical at present, but the fact that these higher physicals can be easily obtained may cause the engineering profession to develop useful applications for them.

This steel is made in two grades, the chemical and physical specifications of which are as follows:

Grade 1		Grade 1-A	
Carbon	0.12 maximum	Carbon	0.30 maximum
Manganese	0.50/1.00	Manganese	0.50/1.00
Copper	0.50/1.50	Copper	0.50/1.50
Nickel	0.40/.80	Nickel	0.40/.80
Molybdenum	0.20 maximum	Molybdenum	0.20 maximum

Physical Properties of Normalized Sheet, Strip and Plates

Yield point	60,000 pounds per square inch, minimum
Tensile strength	75,000 pounds per square inch, minimum
Elongation in 2 inches	25 percent, minimum
Yield point	70,000 pounds per square inch
Tensile strength	90,000 pounds per square inch, minimum
Elongation in 2 inches	18 percent, minimum

It is interesting to note that even with its unusual combination of high strength, corrosion-resistance and ductility this material can be fabricated without difficulty. It lends itself readily to any of the operations required in the construction of railroad equipment or plate fabricated products.

In order to fabricate satisfactorily such large sections which cannot be annealed or heat treated after welding, it is necessary to have a high strength material which does not air-harden. Republic Double Strength steel has little tendency to air-harden; hence it is very adaptable to welding by the arc method. It can also be satisfactorily spot resistance-welded.

With the proper welding wire and procedure, tough, strong welds are readily produced. Material under 16-gage should be spot welded, as it is too light to weld satisfactorily by other means. Arc welding can be accomplished satisfactorily on material as light as 16-gage. No difficulty is encountered in welding the heavier gages.

The metallurgist has a wide choice of alloying elements from which to make selections to use in raising the physical properties of the present structural steel. These alloys fall into two groups or classifications, with regard to the nature of the strengthening effect they have upon the original analysis. The first of these groups is called the carbide formers or pearlitic group of alloys. The second group shows the alloys that affect the strength of the ferrite. They might be called the ferritic alloys.

The carbide group of alloys when added to the regular steel increases the strength by increasing the percentage of Fe_3C, iron carbide. This constituent is governed in the intensity of its effect by the rate of cooling of the metal through the critical range in the last process of fabrication. These alloys produce what is called the air-hardening effect. This air-hardening effect is to be avoided in sheet and strip products as well as in welded plates, for the reason that different gages of sheet and plate—rolled from the same heat—when cooling from the normalizing heat will show considerable difference in physical properties. This condition, when carried out to produce steels strong enough to carry 50 to 100 percent more stress than the present analysis, will require considerable difference in the amounts of alloys required to produce the same range of properties in gages from 20-gage sheet to ¼-inch plate. On this account, this type of alloy steel carries in its analysis a world of grief for the steel producer as well as for the fabricator, as has already been proved.

The ferrite alloys dissolve in the iron matrix and strengthen the basic part of the metal itself. Of these alloys, copper when above 1.0 percent, has a remarkable effect in raising the yield point of the steel without as much effect on the ultimate strength, and very little reduction in elongation. Tests made on regular production sheets of the copper-nickel-molybdenum steels, show an average yield point of 80 to 90 percent of tensile strength and 30 to 35 percent elongation in 2 inches. The addition of 1.40 percent copper, 0.75 percent nickel, and 0.107 percent molybdenum to a steel with 0.08 carbon and 0.70 manganese has produced in normalized sheets (14 gage) a yield point of 70,000 pounds per square inch, an ultimate strength of 80,000 pounds, and

* Metallurgist, Republic Steel Corporation.

30 percent elongation in 2 inches. This same sheet after tempering at 950 degrees F. for one hour showed 95,000 pounds yield point, 100,000 pounds tensile and 25 percent elongation in 2 inches. From the same heat, a ½-inch plate after normalizing showed 65,000 pounds yield point, 74,000 pounds tensile, and 50 percent elongation in 2 inches on the 1½-inch by 2-inch gage length test. Elongation in 8 inches was 31.0 percent. The Izod value was 76 foot-pounds. The longitudinal physical properties of the ½-inch plate after tempering at 950 degrees F. were 89,000 pounds yield point, 99,000 pounds tensile, and 35 percent elongation in 2 inches, 26 percent elongation in 8 inches, and 85 foot-pounds Izod. This is an exceptionally tough condition if we consider the yield point and tensile strength of the steel. Without the copper, nickel and molybdenum addition, this carbon and manganese would not show much over 32,000 pounds yield point and 52,000 pounds tensile in the ½-inch plate, and 38,000 pounds yield point and 56,000 pounds tensile in the normalized 14-gage sheets.

The copper is added for increasing yield point and improving rust-resistance. The nickel combines in the iron with the copper and has a great toughening effect, increasing the Izod or shock resistance of the steel. The molybdenum has the effect of holding both the copper and nickel in solution in the iron. Re-heating in fabrication has very little effect on microstructure or physical properties.

Common practice is to design to a unit stress of 16,000 pounds per square inch and to use 32,000 pounds as the yield point for structural grades of steel. This is a relationship of two to one, as yield point equals twice the calculated stress. With increased speeds the kinetic energy increases in the order of the square of the velocity in feet per second and it is recommended that for safety's sake the factor should be increased to at least 2½ to one, such as 40,000 pounds yield point for a 16,000-pound stress. On this basis, a structure reduced one-third in thickness would develop around 24,000-pounds unit stress, and a 60,000 pounds minimum yield point should be required in the metal. A 40 percent reduction in gages would develop 26,600 pounds stress and require 66,600 pounds yield point, and a 50 percent reduction develops a 32,000-pound stress and should have a minimum 80,000 pounds yield point steel. These yield points and several even higher are being commercially produced in Republic Double Strength steel, and are being applied in various forms of transportation equipment. Some of these units have already been in drastic service for more than a year without a failure to date.

Welding Codes

During the past few months the American Welding Society, New York, has prepared and issued a number of important codes relating to the use of welding. These are:

I—Code for Fusion Welding and Gas Cutting in Building Construction Code 1

The extensive use of welding and gas cutting in the construction and equipment of buildings has brought to the American Welding Society numerous requests from municipal and other authorities for assistance in the formulation of regulations in the revision of existing Building Codes and the compilation of new codes where none is now in force, which will insure the safe and satisfactory use of the processes in building construction. This is a new edition for which the price is 25 cents.

II—American Welding Society Bulletin on Symbols

The revised symbols are intended for use on drawings for all types of products and structures fabricated by fusion welding. They have also been adopted as standard by a number of organizations, classification societies and governmental departments. Price per copy, 5 cents.

III—American Welding Society Marine Code for Welding and Gas Cutting

This part of the "Marine Code for Welding and Gas Cutting" outlines the best commercial practice in the application of fusion welding and gas cutting to the construction of hulls and hull parts of merchant ships. Price per copy, 15 cents.

IV—Tentative Rules for the Fusion Welding of Gravity Tanks, Tank Risers and Towers

Prepared jointly by the American Welding Society and the International Acetylene Association have recently been issued by the National Board of Fire Underwriters, 85 John Street, New York, N. Y. These rules are supplementary to National Board of Boiler and Pressure Vessel Inspectors' Regulations for the Construction and Installation of Tanks, Gravity and Pressure Tank Risers and Towers. The rules open up a large field to use of the fusion welding processes. They apply to the welding of steel gravity tanks supplying water for private fire protection, to welding of risers and towers for such tanks.

Specifications cover materials, qualification tests for operators, welded joint design, workmanship, testing, inspection and stamping. Qualification tests follow rather closely those for A.S.M.E. Class 2 vessels, except as to dimensions of specimens.

V—Tentative Recommendations Describing Preparation for Welding or Cutting Certain Types of Containers Which Have Held Combustibles

These recommendations are intended to apply to the preparation for welding and/or cutting of metal containers which have held flammable solids, liquids, or gases. These practices are equally desirable where any such container is to be subjected to any type of hot work or any operation that might create a spark or flame. Price per copy, 15 cents.

In addition to the above, the following codes are expected to be issued within the coming month:

VI—Tentative Code for Fusion Welding and Flame Cutting in Machinery Construction

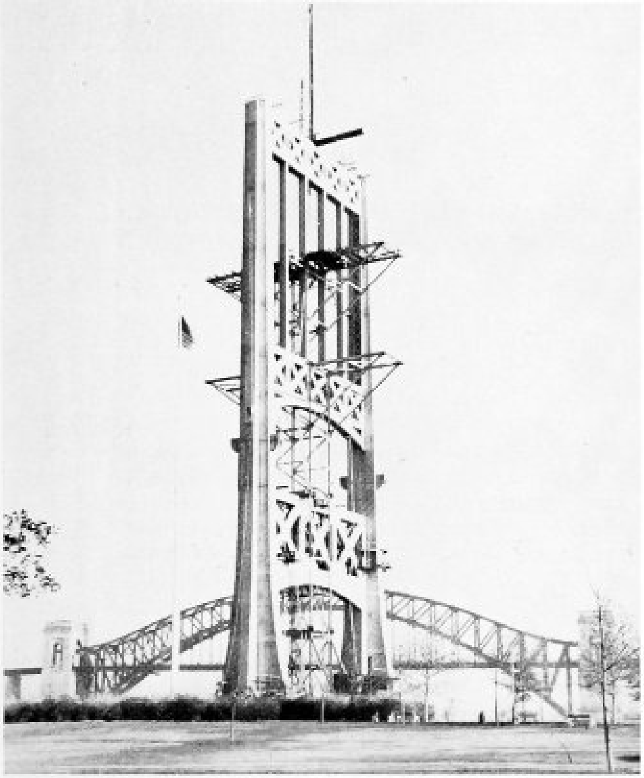
The principal field these specifications are designed to cover is that of machinery and industrial equipment where welded steel structures are substituted for gray iron or steel castings.

The code deals with base metal, filler metal, heat treatment and permissible unit stress. It also includes sections on gas cutting, qualification tests for operators and precautions to be observed. The code is to be copiously illustrated.

VII—Code 2. Code for Resistance Welding of Structural Steel in Building Construction

This code deals with the application of resistance welding to welded steel members.

Copies may be obtained directly from the American Welding Society, 33 West 39th Street, New York.



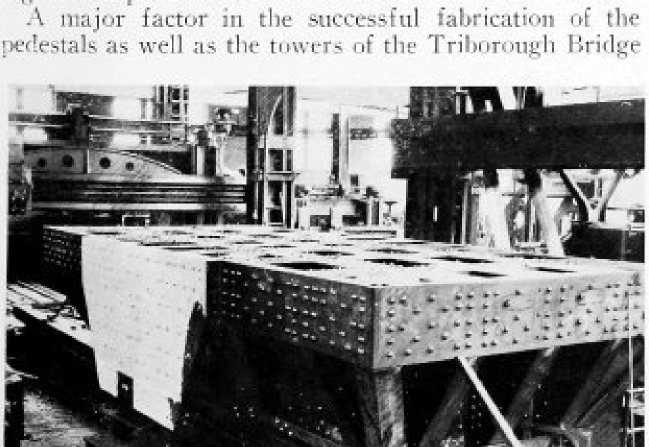
One of the Triborough Bridge towers

Victor Rivets in Triborough Bridge Towers

In no form of structure is the need for good design and workmanship more essential than in bridge construction. The ultimate measure of safety lies in the quality of the joints which hold the structure together. Well riveted and welded joints can result only from good materials and workmanship.

An outstanding example of a bridge embodying these qualities is the Triborough Bridge now under construction in New York. The care exercised in the entire construction of the 350-foot towers for this bridge can best be illustrated by the refinement entering into the fabrication of the pedestals. These pedestals are of riveted construction fabricated within extremely close dimensional limits, the final operation necessitating planing both top and bottom to a tolerance of 0.006 inch.

A major factor in the successful fabrication of the pedestals as well as the towers of the Triborough Bridge is the selection of Victor rivets, which for forty years have been a contribution to the industrial structures of the nation from the Champion Rivet Company of Cleveland.



Extreme accuracy required in fabrication of pedestals

Rules for Smoke Abatement

The Department of Smoke Regulation, of Hudson County, New Jersey, has issued revised Rules and Regulations, governing details of fuel burning equipment, required for issuance of permits and certificates of operation.

These rules and regulations are intended to be a guide to architects, engineers, contractors, equipment manufacturers and building and plant owners. They incorporate requirements covering the issuance of permits and certificates for all construction, reconstruction, alteration and repair work involving any fuel burning apparatus. The object of these rules and regulations is to insure construction of new plants and buildings and changes in existing plants being done in such a manner that smoke will not be made. The residents of Hudson County are determined that smoke in the county be eliminated. The Department of Smoke Regulation, in issuing these rules and regulations, will prevent the construction of future sources of smoke and thus prevent an increase in the list of plants and buildings now smoking because of improperly constructed fuel burning equipment.

The regulations cover power boilers, portable boilers, heating boilers, warm air furnaces, incinerators, water heaters, locomotives, floating equipment, processing furnaces and stills.

Copies of the rules may be obtained from the Department of Smoke Regulation, Board of Health and Vital Statistics of Hudson County, Court House, Jersey City, N. J.

Corrosion of Boiler Drum Heads

Much has been said about the dangers involved in the corroding of concealed boiler drum heads, particularly of the so-called "mud drums" of boilers of the vertical bent-tube type. In fact, this condition is so hazardous that closely bricked-in heads are seldom to be found in the plants of those who are well informed on boiler operation.

It should be emphasized, however, that the uncovering of so-called "blind" heads does not entirely overcome the danger of corrosion wherever brick or mortar prevents a ready examination of the drum, either at the closed end or at the manhole end.

Recently, an inspector discovered a condition of a manhole head which might have caused a disastrous accident. Two bent-tube type boilers had been offered for insurance. The preliminary inspection resulted in numerous recommendations, and while it was not possible, at the time to disturb the brickwork and examine the ends of the mud drums carefully, such an examination was strongly advised at the first convenient opportunity. Soon after the first inspection, the boilers were retubed, and, while under the hydrostatic test, considerable leakage occurred at the seam of a manhole head. This led to the tearing away of part of the brickwork. The head was found to be badly corroded and drilling revealed that at some points it was only $\frac{1}{16}$ inch thick. Continued leakage at the manhole cover was blamed for the corrosion.—*The Locomotive.*

MARINE BOILERS—IV*

By Captain C. A. Jones, U. S. N.† and Lieutenant Commander T. A. Solberg, U. S. N.‡

From a gas path viewpoint the arrangement of the Babcock and Wilcox sectional express boiler shown in Fig. 1 somewhat approaches the ideal. It should be noted that the inclination of the rear headers has the effect of reducing the gas path area and, consequently, the gas velocity progressively increases. This insures more nearly uniform heat transfer rates in the upper portion of the bank. This fact was reflected in the high efficiencies obtained on test and also in the rapid steaming characteristics of the boiler. The tube arrangement, however, is such that considerable gas pressure drop occurred through the bank. A stepped arrangement of tube spacing throughout the bank might have been productive of better results in every direction and, furthermore, would have resulted in some weight saving.

The heating surface of a boiler, in effect, should be arranged so as to obtain the beneficial effects of stream-

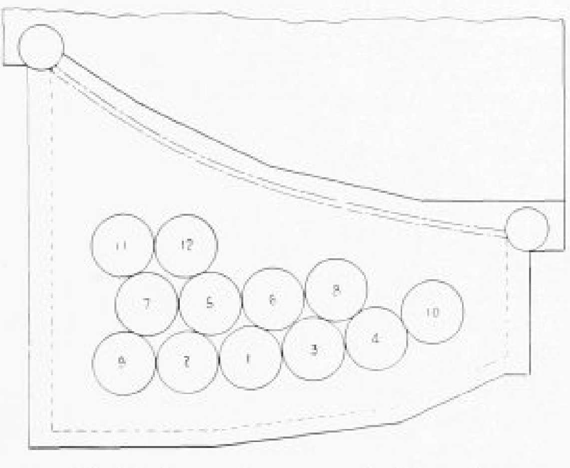


Fig. 10.—Improved arrangement of burners for boiler shown in Fig. 1

lining. The Naval Boiler Laboratory conducted some extensive tests on the effect of bank angling in an *A*-type boiler. By bank angling is meant removing a triangular nest of tubes at the rear outer corners of each bank. Six different conditions of angling were tried.

Bank angling provides opportunities for installing large unheated downcomers in the areas thus made available. Additional rows of tubes may be added in the tube bank to compensate for any net loss in heating surface.

In connection with bank angling it is believed that much can be accomplished if careful study is made of tube spacing and arrangement. Present practice usually utilizes fixed spacing throughout the boilers for tubes of the same size. Deviations from this might be productive of better heat transfer and lower pressure drops. The improvements in modern condensers which were effected along similar lines are illustrative of what might be accomplished.

(*k*) *Burner Arrangement.* A proper burner arrangement is essential to efficient combustion and especially so in the constricted furnaces of naval boilers. The first essential is to place the burners so that the refractory surface and particularly that of the furnace floor will be utilized to support and promote combustion.

Figs. 1 and 10 show two arrangements of burners in the same furnace. The former was the first installation and originally was considered as good as could be obtained. Accumulated information indicates, however, that an increase in efficiency of at least one percent may be gained by rearranging the same burners as shown in Fig. 10. The numbered circles indicate the preferred lighting-off order and the best burner combinations for maximum efficiency. If five burners were to be used, for instance, numbers 1 to 5 could be kept in service continuously.

Although different burner types vary somewhat, the general rule is to keep the center of the burners at least 30 inches from tube (or cold) surfaces and approximately 28 and 26 inches from furnace walls and floors. These figures vary with the type of burner.

In Fig. 7, which is the burner set-up for a 4-drum express boiler, the number 10 burner militates against maximum efficiency at high ratings because of being almost surrounded by cold surfaces. In order to provide better clearance and prevent striking of the refractory, burners have often been tilted or inclined. Tests have been conducted at the Naval Boiler Laboratory to determine the effects of such tilting but invariably it has been shown that the "straight shot" arrangement is superior. It is believed the reason for this lies in the fact that when burners are angled, there is an interference with adjacent burners, resulting in higher pressures and non-uniformity of combustion.

It often is found that the gas paths, boiler water heating surface disposition, and the burner installation are not mutually conducive to the best efficiencies. In other words, these three factors should be considered together in such a way that every part of the heating surface will do its rightful share of the work. Observations of many boilers in operation, as well as analysis of test results, disclose that rarely do these conditions obtain and in most instances provisions could have been made for securing such desiderata. Two flagrant cases in point involve the existence of large by-pass areas around interdeck superheaters which might easily have been avoided. Many other cases have been studied in which it was discovered that certain portions of the tube banks contributed but little to the boiler performance at all operating rates.

(*l*) *Refractory Materials.* All refractory and insulating materials used in naval boilers must pass an acceptance test in the regular test furnaces at the Naval Boiler Laboratory. Recently, various suitable refractories have been rated on a work-factor basis so that all

* Fourth and last instalment of a paper read before The Society of Naval Architects and Marine Engineers, New York, November 16, 1934.

† Head of Design and Construction Division, Bureau of Engineering, Navy Department, Washington, D. C.

‡ Officer-in-Charge, Naval Boiler Laboratory, Navy Yard, Philadelphia, Pa.

purchases eventually can be made using the work-factor values obtained in these tests. Practically all the large brick manufacturers are in hearty accord with this method of purchase. The properties of the brick used in determining the work factor are the specific weight pyrometric cone equivalent, and resistance to spalling. Other properties, such as refractoriness, performance in test furnace, and chemical make-up are used in determining individual suitability.

Where purchases must be made on a competitive basis, where there is a wide variation in quality and where the performance is capable of being reasonably easy of determination, a similar method of purchase has been used by the Navy for other materials such as storage batteries, cutting steels, crucibles, etc., and has proven most satisfactory.

The furnace floors recently adopted for naval boilers consist of one layer of 1-inch uncalcined block, one layer of 2½-inch calcined diatomaceous earth, and one layer of standard 2½-inch refractory brick. These are laid so that joints are broken and a thin, quick-setting, air-drying cement is used for laying up the refractory brick. Furnace side and back walls have a similar construction, using respectively 1 inch, 2½ inches, and 4½ inches of the above.

Anchor bolts of a heat resisting material, such as Inconel, must be used for support of the walls. Naval boilers naturally require more anchor bolts than merchant vessel furnaces because they must withstand the shocks of heavy gunfire and frequent radical changes in temperatures.

(*m*) *Miscellaneous Factors.* The use of automatic devices for such purposes as controlling feed-water levels, feed temperatures, and fuel-oil temperature or viscosity is being applied gradually to marine boiler plants. It is also noticeable that more and more direct reading and recording instruments, which give accurate indications of existing conditions and thereby assist in providing better operation, are being installed. Instruments covering CO_2, pressures, temperatures, drafts, smoke, and salinity have been developed in some cases especially for shipboard applications. The final aim in all engineering progress is the attainment of better operating results. Apparatus which is of assistance in this respect is worthy of consideration.

Extensive use in stationary practice has demonstrated the value of such equipment, and marine engineers have been slowly adopting many of these devices. There is, however, a real and vital objection on the part of the Navy to automatic devices which actually control operation. This objection is due in the main to the fact that derangements would occur in time of action and due to the dependence of the personnel on these devices in peace time they would not have been properly trained to handle operations when the derangement occurred.

Soot blowers are now specified for all naval boilers and in many cases are being added to existing units. The maintenance of clean firesides is realized now to be of great importance. Used intelligently in connection with smoke pipe or uptake temperature indications, they result in great fuel savings; operated in a haphazard manner, the results are mediocre.

It is believed also that there is a field for better cleaning of firesides than ordinarily can be accomplished with soot blowers. The cracked oils now coming into use cause deposits which are not removed completely by soot blowers, especially within the tube banks at points remote from the blower elements. The accumulation of these deposits may become a serious matter. It is probable that some method of washing the firesides at periodic intervals will be required. The methods devised by Lieutenant Commander B. M. Thompson, U.S.N. (Retired), or some slight modification of them may be practicable.

(*n*) *Feed-Water Treatment.* The improvements which have been made in boiler feed-water treatment in the last ten years have had considerable effect on both boiler design and boiler operating efficiencies. The large, straight-tube boilers have been favored for many years because they were relatively easy to clean on the water side. In many cases boiler scale was tolerated until tube troubles commenced; while in other cases, especially those of fast liners, expensive turbining of tubes was carried out systematically. Gradually, but very slowly, this state of affairs is being changed. There are now available methods of feed-water treatment which will definitely prevent new scale formations and also will remove existing scale. The use of these systems of water treatment makes boiler cleaning practically unnecessary and also insures functioning of the water sides at maximum efficiency at all times. Toleration of scale in boilers today is a mark of poor engineering practice. Constant improvement in some of the recognized methods of treatment has resulted also in their simplification, so that merchant vessels bunkering water at various ports can secure equally good results by slight variations of the prescribed treatment.

Despite the fact that water treatments of known value are available, it is apparent that many compounds and treatments continue to do a thriving business with practically no beneficial returns to the user. The number of pounds of worthless compounds, the pounds of compounds containing at least one questionable or harmful ingredient, and the pounds of chemicals of useful nature which are misapplied or inefficiently used could be converted into a money total running a close second to the total money value of the cosmetic industry.

Boiler Design Possibilities

Improvement in all branches of engineering is continual though not always marked. In general, engineering advances must be made most carefully. Radical departures are not usual unless first tested by experiment or actual test.

The question of using high-tensile alloys for naval boiler parts has been given much thought and their use for certain parts would undoubtedly serve to promote some weight saving when used for casing and structure parts. Unfortunately, however, the corrosion fatigue characteristics of the higher tensile steels is little better than the Class *B* steel; therefore, for those parts subjected to corrosion fatigue there would be little or no advantage from a weight point of view. Extensive investigation, however, is being made for using alloy steels for tubes, etc., where due to their much higher oxidation temperature limit their use does allow operation at higher ratings and higher steam temperature. The non-scaling properties of some of the alloy steels are also of distinct advantage.

As to the general design of boilers there are many possibilities. Various boiler types of high capacity having low weight and space factors are now being developed and tried. The effect of new fuels also may have an effect on new designs. If necessity demands, it is quite possible to reduce the boiler water heating surface radically and install in lieu thereof high-capacity air heaters, so that efficient combustion of slow-burning fuels can be insured. It well may transpire that fuel oils will have characteristics which will dictate the use of heated air to obtain satisfactory combustion. This need will be most apparent in small furnaces having high heat releases. It is considered desirable even with present fuels to increase the furnace temperatures as much as possible. This involves, however, the development of better refractories than those now available.

In conclusion it may be stated that although considerable improvement has been made in boiler performance during the past ten years, there is still considerable room for refinement of design and investigation work looking toward general improvement in boiler performance. With the use of high pressures and temperatures firmly established, it is predicted that the next ten years will see changes in marine and naval boilers equally as great, and perhaps entirely different from those of the past decade. Literature and information from abroad indicate that they have gone farther and farther with the actual experimental work on steam generators of a new and novel design than anything done in this country. A reading of some of their reports of actual ship installation, especially an article by Doctor E. Goos in the last *Year Book* of the Shipbuilding Society in Germany, would indicate that the installation was attended with considerable success. There are, however, at least two vital reasons for the slow progress in the development of the marine boiler. First, a major casualty usually results in a large loss of life, and, second, conclusive experimental work must be carried out on full scale and this is an extremely expensive matter.

Welders Review Year of Progress

Increased membership with organization of additional sections well advanced at Baltimore and Milwaukee and proposed chapters at Toledo, Salt Lake City and Denver, are indicative of a year of progress as reported at the sixteenth annual meeting of the American Welding Society, Hotel Pennsylvania, New York, April 25.

Not only were sectional activities productive of increased interest in welding, but reports of special committees also revealed steady progress.

Dr. D. S. Jacobus, Babcock & Wilcox Company, New York, retiring president, was presented with a past-president's medal.

J. J. Crowe, Air Reduction Sales Company, Jersey City, N. J., was elected president, and E. R. Fish, Hartford Steam Boiler Inspection & Insurance Company, senior vice-president.

New divisional vice-presidents include: Turner C. Smith, General Petroleum Corporation of California, Los Angeles, Pacific Coast section, and E. E. Gillman, Wyatt Metal & Boiler Company, Dallas, Tex., southern section.

New directors are C. A. Adams, Harvard engineering school, Cambridge, Mass.; H. M. Hobart, General Electric Company, Schenectady, N. Y.; F. T. Llewellyn, United States Steel Corporation, New York; K. D. Spackman, Lukenweld, Inc., Coatesville, Pa., and H. L. Whitney, M. W. Kellogg Company, New York.

In approximately 140 cities welding codes have been adopted, in whole or in part in the building regulations of these municipalities, the committee being active in co-operation.

Code 2 for resistance welding of structural steel restricts application of resistance welding on some lighter members, such as joists, light trusses, stair stringers and other small parts, which by reason of their shop fabrication in multiple quantities, can be subjected to definite qualification tests. Allowable working stresses are the same as those in code 1 and a minimum safety factor of 3 is required for the weakest member or joint of any product manufactured by resistance welding equipment.

The Philadelphia city planning commission requested this code, while the department of internal affairs of Pennsylvania was given data on the revised code for the application of fusion welding to structural steel. The department is working on a proposed building code for the state.

Welding data were also supplied New Britain, Conn., for inclusion in building rules of that city. Similar information was also given Chicago to assist in the preparations of welding regulations for a revised building code. Numerous requests from other cities and public work departments have applied for material to be used in building regulations. G. D. Fish is chairman of this committee.

Application has been made for a charter by the recently-organized Baltimore section following a promotional meeting at which considerable interest developed with the election of officers. Organization of a Milwaukee section is well under way, with temporary officers elected.

President D. S. Jacobus reported in detail activities of the year and reports of the work of all sectional chapters were briefly submitted. At Philadelphia a lecture course resulted in an increase of 100 new members. Chicago was active in the organization of Milwaukee, and 400 attended the meeting in the latter city. Detroit has been active in building enrollment from the resistance welding field.

Boston was instrumental in overcoming detrimental legislation, including a proposal requiring a five-year apprenticeship for welders. A start has also been made in the organization of new sections at Salt Lake City and Denver. New York is considering an extension course for welding operators. Cleveland has been increasing its membership, especially the sustaining grade. Plans are also being considered for Toledo, O., section.

A net gain of 239 members was made during the year and efforts to enlarge the rolls are expected to be stimulated by publication of a proposed welding manual or handbook.

Work is progressing on a preliminary code report by the committee on rules for welded construction of oil storage tanks. Following the collapse of a welded tank at Tiverton, R. I., more than a year ago, much interest has been shown in the work of this committee. This code will take into consideration many different types and forms of tank construction and will be so formulated as to cause no interference with the ingenuity of engineers in their design work. The new code will furnish data to assist engineers in the production of welded tanks that will be pre-eminently safe and that will also give satisfactory service.

A new project on design of welded penstocks has been initiated by the appointment of a committee with Dr. W. F. Durand as chairman, composed of the highest authorities on the subject.

Efforts of the committee to obtain agreement on a plan of uniform qualification rules for operators have been beset with difficulties. There has been emphatic evidence of the desire on the part of many greatly to simplify and abbreviate the qualification test procedure in order to save expense.

Between these two extremes there seemed, for a long time, to be no easy compromise, until at a recent meeting the modified plan of separating the process qualification from the tests for qualifying the welders was proposed. A revised draft of the proposed code of uniform tests has been prepared and is in the hands of the committee.

This new development is the result of the inevitable consideration that any tests schedule for qualifying a welding operator must, of necessity, embrace the welding process to some extent. In order to qualify, an operator must be provided with suitable welding equipment and materials; the best and most experienced operator may fail in his tests if not provided with a suitable process to demonstrate his fitness.

It is, therefore, the intent of the present proposal of the committee to place the tests on a revised basis wherein the welding process is first qualified to determine its ability to meet any specified requirements, and then by means of a few inexpensive tests, to determine the ability of a welding operator to properly apply that process.

There has been increased activity in the work of the A. S. M. E. boiler code committee. One of the most important questions which the conference committee has been called upon to consider in its recent work is the much discussed question of acceptability of welding on gas cut plate edges.

Recently the practice of shaping the welding edges of plates by gas cutting machines has become prevalent, but inspectors who were ignorant of the results of the gas cutting process have been inclined to treat gas cut edges in the same manner as sheared edges and have required the machining or chipping of the gas cut edge down to bright metal.

The recommendation of the conference committee has assisted the boiler code committee in determining the facts and establishing the conditions under which welding on such gas cut edges is permissible.

The final draft of the pressure pipe code which was formulated and formally presented for public hearing and approved by the board of directors of the society is to be incorporated as a part of the American Marine Standards Committee general code for pressure piping. The welding section is to be noted as section 5 of the pressure piping code.

The pressure piping code has been finally approved by letter ballot of the sectional committee formulating it and by the A. S. M. E. which is the sponsoring body. It has also been approved by the American Marine Standards Committee.

Because the National Research council finds it no longer possible to sponsor the work of the American Bureau of Welding and to contribute to its support as it has in the past, and owing to the fact that most of the agencies now co-operating in the work of the bureau are inactive in that connection, there seems to be no good reason for continuing the present form of organization and it has been proposed to make the present work of the bureau an integral part of the activities of the American Welding Society.

Sale of Machine Tools Increasing

Machine tool sales have been increasing steadily during the last two months and May is expected to show a further substantial improvement over April, it was stated today by C. J. Stilwell, vice president of the Warner & Swasey Company, Cleveland machine tool manufacturers, and president of the National Machine Tool Builders Association.

"Not only is the volume of orders larger," said Stilwell, "but there is a better distribution of orders. Many people are now buying who have not purchased machine tools for a number of years.

"The improvement appears to be the result of a normal resumption of the demand which has been accumulating throughout the depression. The increase in sales of consumers goods has naturally been reflected in a growing demand for machine tools from manufacturers of consumers' goods. In addition there is a growing volume of orders from the durable goods field. Makers of durable goods have so long deferred machine tool purchases that today any resumption of activity in this field is immediately reflected in machine tool orders.

"Machine tool exports have barely been holding their own and have not reflected improving business conditions abroad due to price differentials and various artificial trade restrictions imposed by European governments.

"While many machine tool plants are still running at a loss or on a subnormal basis, there is much more optimism in the industry than there has been for a long time. Spring buying has developed so rapidly that whereas up until recently deliveries could be made from the shelf, they are now being made on a four to six weeks basis, and it is expected that within another month deliveries will have to be named on a still longer basis on many types of machines.

"While the normal seasonal recession in the trade may be expected during July and August, it is anticipated that following the National Machine Tool Exposition, to be held in Cleveland in September, another period of increased buying will develop."

Baltimore Welding Distributor Moves to Larger Quarters

T. A. Canty, Baltimore, Md., distributor of arc welding equipment and supplies manufactured by The Lincoln Electric Company, Cleveland, has found it necessary, due to substantially increased business, to move from its former location at 116 East Centre Street to much larger quarters at 1023 Cathedral Street.

In addition to providing every assistance in arc welding problems, the company will maintain a complete stock of arc welding machines, electrodes and supplies for welding.

The most recent developments include the latest models of the well known Shield Arc welder and two new electrodes, "Abrasoweld" for super hardness and "Toolweld" for making cutting edges on metal and woodworking tools.

Lukens Moves New York Office

According to an announcement of George L. Gordon, general manager of sales, Lukens Steel Company, the New York offices of the company have been moved to new quarters in Suite 2714-15 in the Chrysler Building, 405 Lexington Avenue.

Whiting Plant of Carbide and Carbon Chemicals Corporation

During March the new plant of the Carbide and Carbon Chemicals Corporation at Whiting, Ind., was placed in operation. The plant occupies part of a thirty-acre tract of land lying between the main lines of the New York Central and Pennsylvania Railroads, and faces a main motor highway between Chicago and the East. The plot selected allows ample space for expansion.

The completion of this plant is an additional important step in the development of the chemical industry by this corporation. This development has grown out of fundamental research in organic chemistry originally started to investigate the possibility of manufacturing new products from hydrocarbon raw materials. The corporation now produces and sells a wide range of chemical products which are used extensively in many industries requiring solvents and related products.

Copper Alloy Sheets

The rapid strides being made by pre-chromed copper and copper alloy sheets into new manufacturing fields is the keynote of the May issue of the Copper & Brass Research Association's *Bulletin*.

Of striking interest is an illustrated article showing copper objects excavated by archæologists from buried cities of the Incas in South America. Most of these objects, explains the *Bulletin*, can be traced to a civilization that flourished from 4000 to 7000 years ago. Every uncovered item is of copper or a copper alloy and all were found in absolutely perfect condition. The group of metal objects ranged from instruments used in daily life, such as knives, maces, sledge-hammers, fish-hooks, powder and rouge boxes, mirrors, needles and such to highly ornamented decorations and religious figures. "To the durability of copper," declares the *Bulletin*, "can be credited today's knowledge of the daily life of the prehistoric Incas."

Death of Stewart A. Jellett

On April 5, Stewart A. Jellett, charter member, presidential member and honorary member of the American Society of Heating and Ventilating Engineers, died at his home in Philadelphia at the age of 73.

Stewart A. Jellett was a pioneer in heating and ventilating engineering and was one of the few privileged to live long enough to realize and enjoy the great developments which occurred in this field during the last half century.

From 1889 to 1912 Mr. Jellett was successively engineer, manager, vice-president and treasurer for Francis Bros. and Jellett, Inc., during which time he had charge of all engineering design and construction which included such important work as the Philadelphia Bourse Building, numerous buildings at the University of Pennsylvania and at Bryn Mawr College, a number of hotels and institutional buildings in New York City, and Carnegie Libraries in Denver and several other cities.

From 1912 until his death Mr. Jellett was president of the Stewart A. Jellett Company and was responsible for the design and installation of a great many heating, ventilation and electric generating plants.

Changes in Republic Offices and Organization

On May 1 the New York District Sales Office of the Republic Steel Corporation was removed to the Chrysler Building, according to an announcement by N. J. Clarke, vice-president in Charge of Sales for Republic.

W. H. Oliver continues in charge of the office as district sales manager. Republic's export department, under the direction of D. H. Bellamore, general export manager, will also occupy a portion of Republic's new suite in the Chrysler Building.

It was also announced that Enduro stainless steel will be distributed by the Gilmore Steel & Supply Company, 825 Folsom Street, San Francisco, Cal. With the appointment of the Gilmore Steel & Supply Company, there are now available 45 warehouse stocks of Enduro stainless steel in principal cities from coast to coast.

Effective May 18, the Philadelphia District Sales Office of Republic Steel Corporation, and subsidiaries, Berger Manufacturing Company, and Union Drawn Steel Company, will be removed from the Fidelity-Philadelphia Trust Building, to the Broad Street Station Building, 1617 Pennsylvania Boulevard. J. B. DeWolf continues in charge of the office as district sales manager, assisted by the present staff.

Lee Wright has been appointed sales representative for Republic Steel Corporation, with headquarters at 401 Atlas Building, Salt Lake City. Prior to his connection with Republic, Mr. Wright had been associated with Zion's Co-operative Mercantile Institution, Salt Lake City, since 1902. He was first in the express department, later transferring to the heavy hardware and shelf hardware department. Under his management that department developed so much that it was necessary three times to increase the floor space devoted to it and to enlarge the warehouse facilities. The appointment will enable Republic to serve more efficiently the Salt Lake City territory, which in the past has been handled through Republic's Denver Office.

Budget for Steel Plate Fabricating Industry

The Code Authority for the Steel Fabricating Industry has made application to the National Industrial Recovery Board for the approval of its budget for, and of the basis of contribution by members of the Industry, to, the expense of administering the Code for the period from May 1, 1935 to April 30, 1936.

The total amount of said budget for the said period is $59,050. After taking account of surplus funds on hand from previous operations, the basis of contribution designed to provide approximately $50,000 of the amount of the proposed budget is two-tenths of one percent of the total monthly billings of fabricated materials coming within the jurisdiction of the code for the industry.

Notice was given on April 23, that any criticisms of, objections to, or suggestions concerning this budget and the basis of contribution were to be submitted to Acting Division Administrator Robert N. Campbell, Room 704, Albee Building, Washington, D. C., prior to Monday, May 13, and that the National Industrial Recovery Board might approve the budget and basis of contribution in their present form and/or in such form, substance, wording and/or scope as they may be revised on the basis of criticisms, objections, or suggestions submitted and supporting facts received pursuant to this notice, or other considerations properly before the National Industrial Recovery Board.

Boiler Maker and Plate Fabricator

VOLUME XXXV NUMBER 5

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Request for change of address should reach us on or before the 15th of the month preceding the issue with which it is to go into effect. It is difficult and often impossible, to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address, please be sure to send us your old address as well as the new one.

BOILER MAKER AND PLATE FABRICATOR is a member of the Associated Business Papers, Inc. (A. B. P.), and the Audit Bureau of Circulation, (A. B. C.).

EDITORIAL STAFF: H. H. Brown, Editor. L. S. Blodgett, Managing Editor

Contents

Trade Publications

Press.—Niagara Machine & Tool Works, Buffalo, N. Y., has issued a bulletin on its A-5 heavy duty presses, illustrating various types, with details and description of new features.

Enduro Stainless Steel.—The many advantages of Enduro in the tanks and vats used by the textile industry are outlined in a bulletin being sent out by the Republic Steel Corporation, Massillon, O. The fabricator of textile equipment will find the studies of the bleaching and dyeing problems made by Republic in the development of stainless steels to meet textile requirements of considerable value. In requesting copies of the bulletin refer to Form ADV 146.

Forged Flanges.—Taylor Forge & Pipe Works, Box 485, Chicago, Ill., has issued a 96-page catalogue, No. 35, on its forged steel pipe flanges, containing data and formulas approved by engineering societies. Alloy steels, joint bolting and gaskets are also discussed.

Press Brake.—Lukens Steel Company, Coatesville, Pa., in a current bulletin features its new Cincinnati all-steel press brake, which is capable of producing various sections in plates up to one inch thick and lengths to 18 feet, bending, flanging, forming and multiple punching of light or heavy steel plate. Illustrations show the press, its dimensions and many of the products it can form.

Tube Bender.—The Parker Appliance Company, Cleveland, O., is distributing a bulletin describing the production tube bender made by the company. This is a tool which may be quickly set up for any class of work within the limits of its design. Tubes may be fabricated to specification and duplicated with accuracy and satisfactory speed.

Welding Electrodes.—Heavy mineral-coated welding electrodes, sold under the trade name, "Murex," are described in a bulletin issued by the Metal & Thermit Corporation, New York. In general, a Murex electrode consists of a steel core of highest quality welding wire on which asbestos yarn is wound in an open spiral and a carefully designed mineral coating is extruded under high pressure.

Return Tubular Boilers.—A catalogue covering general specifications for horizontal return tubular boilers, built by the Combustion Engineering Company, Inc., New York, has been issued recently. These boilers were formerly known to the trade under the names of Casey-Hedges and Walsh-Weidener. Both riveted and fusion welded construction for the shells is shown and various details of the boilers, grates, breechings, etc., are included, as well as general information on settings.

Steel Plates.—Lukens Steel Company, Coatesville, Pa., has issued a new chart which shows the sizes of rectangular plates produced by the company. One section of the table shows sizes of sheared or flame-cut plates in the extreme dimensions rolled on the 206-inch plate-rolling mill, which is the largest in the world. Thicknesses are shown up to 25 inches and widths up to 186 inches. Thick steel plates are finding increasing application in bases and welded structures, in die work and machinery. Extremely wide plates shown are coming into use for reason of economy and safety in the fabrication of boilers, tanks, and pressure vessels.

Thor Pneumatic Tools.—The Independent Pneumatic Tool Company, Chicago, Ill., has issued Pneumatic Tool Catalog No. 50, illustrating in its entirety, the pneumatic tools manufactured under the Thor trademark. In this catalog is a very complete showing of these pneumatic tools with complete specifications, etc., together with illustrations covering each type of tool. The rotary tools included are drills, wood boring machines, close corner drills, screw-drivers, right-angle nut setters, tapping machines, wrenches, air grinders, brushes, cone grinders and cone sanders, and rod grinders. The piston tools shown include air drills, wood boring machines, close corner drills, wrenches and heavy tube rollers. In the pneumatic hammer section are shown chipping, scaling and riveting hammers and rivet sets. In addition to these tools are shown pneumatic tool accessories and a general showing of universal electric tools, high frequency electric tools and contractors' and mining tools.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on practical boiler shop problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given special permission to do so.

By George M. Davies

Attaching Steam Dome to Boiler

Q.—Would you please favor us with an example, in as much detail as possible, of how to apply the rules of Par. 193-c of the A.S.M.E. Code, to rivets attaching a dome or manhole to a boiler? Both the dome and manhole saddle are double riveted to the boiler and we are not certain that our understanding of the detailed calculations under the rules of Par. 193-c is correct. It seems to us that these rules should not apply to such construction because the dome head is stayed to the boiler, and because the manhole saddle is inside the shell. Under these circumstances, it is hard to see how the shell plate could tear through the rivet holes. However, since there appears to be considerable difference of opinion about it, we would like to have an example of the detailed calculations as soon as convenient to you.—R. D.

A.—Par. P-193(c) referred to in the question is as follows:

P-193(c). When tubes or holes are arranged in a drum or shell in symmetrical groups along lines parallel to the axis and the same spacing is used for each group, the efficiency for one of the groups shall not be less than the efficiency on which the maximum allowable working pressure is based.

When tubes or holes are unsymmetrically spaced, the average ligament efficiency shall not be less than the following:

(1) For a length equal to the inside diameter of the drum for the position which gives the minimum efficiency, the efficiency shall not be less than that on which the maximum allowable working pressure is based. When the diameter of the drum exceeds 60 inches the length shall be taken as 60 inches in applying this rule.

(2) For a length equal to the inside radius of the drum for the position which gives the minimum efficiency, the efficiency shall not be less than 80 percent of that on which the maximum allowable working pressure is based. When the radius of the drum exceeds 30 inches, the length shall be taken as 30 inches in applying this rule.

(3) The width of the ligament between any two adjacent holes shall not be less than that given by formula (3) in (b) making d' in the formula equal the average diameter of the holes at the two sides of the ligament and employing the value of d obtained from either formula (1) or (2) in (b).

For holes placed longitudinally along a drum but which do not come in a straight line the above rules for calculating efficiency shall hold, except that the equivalent longitudinal width of a diagonal ligament shall be used. To obtain the equivalent width, the longitudinal pitch of the two holes having a diagonal ligament shall be multiplied by the efficiency of the diagonal ligament. The efficiency to be used for the diagonal ligaments is given in Fig. P-13.

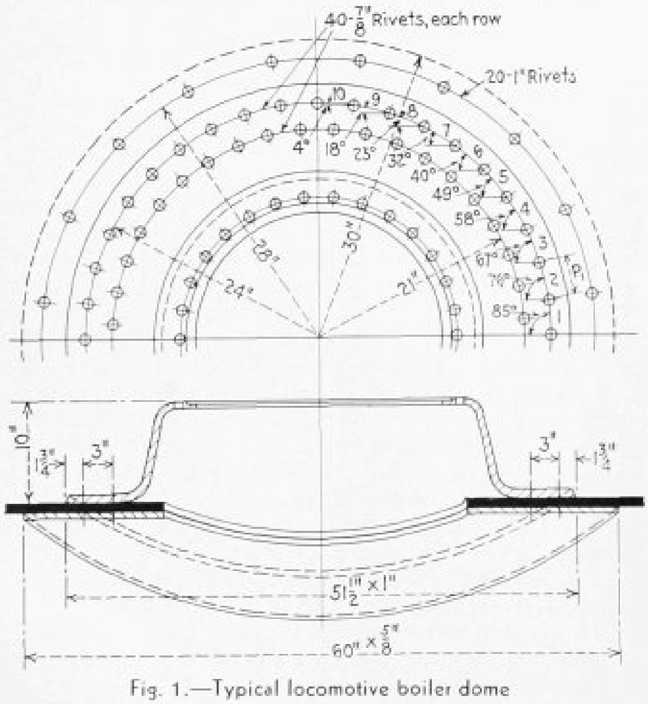

Fig. 1.—Typical locomotive boiler dome

Fig. 1 illustrates a typical locomotive type boiler dome secured to the shell of the boiler.

As an example the shell will be computed for tearing around through the outside row of rivets of the dome.

The boiler is 87½ inches inside diameter at the dome course.

The efficiency of the longitudinal seam of the dome course is 93.3 percent and will be taken as the course upon which the working pressure is computed.

$$P_1 = 2\,R \times \text{Sine}\,\frac{A^\circ}{2}$$

where; R = radius of rivet circle in inches = 24 inches

$$A^\circ = \text{angle of rivet spacing}\ \frac{360}{40} = 9 \text{ degrees}$$

$$P_1 = 2 \times 24 \times \frac{0.15643}{2} = 3.75 \text{ inches}$$

$$\frac{P_1}{D'} = \frac{3.75}{0.9375} = 4$$

Ligament	Angle degrees	$P_L = P_1 \times$ Cosine Angle	E Fig. P-13 1931 edition	$P_L \times E$
1	85	3.75 × 0.0872 = 0.327	1.40	0.458
2	76	3.75 × 0.2419 = 0.907	1.29	1.170
3	67	3.75 × 0.3907 = 1.465	1.17	1.714
4	58	3.75 × 0.5299 = 1.987	1.045	2.076
5	49	3.75 × 0.6506 = 2.439	0.935	2.280
6	40	3.75 × 0.7660 = 2.872	0.86	2.470
7	32	3.75 × 0.8480 = 3.18	0.81	2.575
8	23	3.75 × 0.9205 = 3.45	0.775	2.673
9	18	3.75 × 0.9501 = 3.562	0.7625	2.716
10	4	3.75 × 0.9975 = 3.74	0.75	2.805
				20.937 × 2 = 41.874 inches

Equivalent length removed from shell

$$(48 + 0.9375) - 41.874 = 7.0635$$

Actual efficiency of shell = 93.3 percent

Efficiency using rule (1) of Par. P-193(c)

$$E = \frac{60 - 7.0635}{60} = 88.2 \text{ percent}$$

80 percent of actual efficiency $= 0.8 \times 93.3 = 74.6$ percent

Efficiency using Rule (2) of Par. P-193(c)

$$E = \frac{30 - 7.0635}{30} = 76.4 \text{ percent}$$

Therefore meeting the requirements of Par. P-193(c).

These rules apply to any construction on the shell of a boiler where a series of holes are drilled longitudinally into the shell, which will permit the shell to tear around through the holes.

I believe these rules would apply to the conditions outlined in the question as the staying of the dome head and the fact that the manhole saddle is inside the shell would not prevent the shell from tearing through the rivet holes, which fasten the manhole saddle or the dome to the boiler.

Water Level Indications

Q.—Would like to know if you could give me some information on the following: We have several engines which have been equipped with feed-water heaters and complaints have been coming in about the water in the glass not registering properly. When the engine is working hard on the road it seems to bubble and circulate in the glass. The mountings have the company's standard extension on them and are not obstructed in any way by stays. Perhaps some of your readers have come across this problem and I would appreciate it very much if I could be put right on the matter.—S. E. R.

A.—From the information given in the question, I understood that improper registering of the water in the water glass is only on those engines which have recently been equipped with feed-water heaters and that the conditions outlined have developed since the feed-water heaters were applied.

The action of the water in the glass as explained in the question would indicate that the water in the boiler was foaming.

Foaming in a boiler is due to the fact that the suspended particles collect on the surface of the water in the boiler and render difficult the liberation of steam bubbles arising to the surface.

Feed-water heaters use exhaust steam from the exhaust passages of the cylinders, which steam collects a certain amount of oil from the cylinders. This steam condenses and is returned to the tank.

The usual practice is to have an oil filter or separator to remove the oil from the condensate before it is emptied into the tank.

It is possible that on the engines in question, the oil separator is not functioning properly and oil in the feed-water heater condensate is being passed into the boiler. This oil would tend to loosen the scale in the boiler and in itself cause a film on the top of the water which would tend to induce foaming.

This condition would be exaggerated if the engines were not equipped with water columns.

Slope of Crown Sheet

Q.—Why is it necessary to have the crown sheet in a locomotive boiler firebox slope away from the tube sheet toward the fire door, or back sheet of firebox?—W. B.

A.—The crown sheet of a locomotive firebox is sloped from front to back for the following reasons:

(1) The crown sheet of the firebox of a locomotive boiler is sloped so that its top surface will remain covered with water when the locomotive is heading down or backing up a grade.

Fig. 1 shows a straight-crown firebox when the locomotive is on a down grade. The front of the crown sheet is covered with water, while the back is uncovered.

Fig. 2 shows a sloping-crown firebox when the locomotive is on a down grade. The entire crown sheet is in this case covered with water.

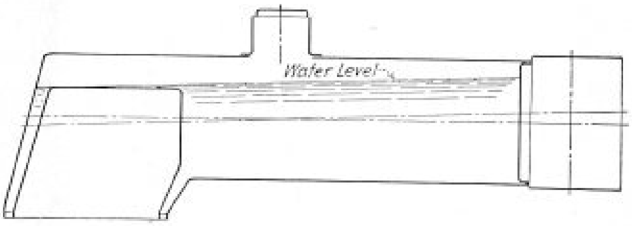

Fig. 1.—Straight-crown firebox, with locomotive on down grade

(2) With a sloping crown the heat strikes the crown sheet more uniformly and is more evenly distributed, thereby causing less strain on the sheet and giving greater life to crown sheets and better results.

(3) In case of low water the highest point in the crown sheet will become overheated first, and in all probability will let go quicker and do less damage than if it had no slope.

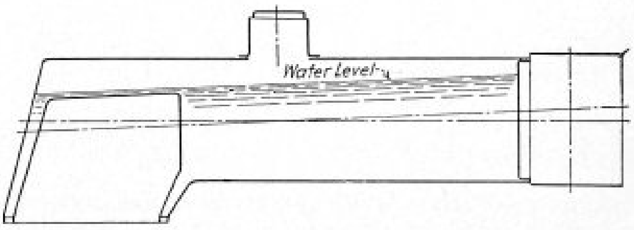

Fig. 2.—Sloping-crown firebox with locomotive on down grade

(4) There is more combustion of heat units in the front end than in the rear end of the firebox, and more room is allowed for combustion to take place.

(5) A greater amount of heat surface can be used at the front than at the rear end.

(6) It gives more room for flue spacing in the back flue sheet.

(7) It also gives more room for cab and cab mountings on the outside, where the wrapper sheet tapers with the crown sheet.

Protection of Boiler Tubes from High Heat

Q.—What practical steps may be taken to enable boiler and superheater tubes to withstand higher temperatures?—L. B.

A.—There are various possibilities. One is the use of tubes made of special alloy steel, usually containing some chromium, which is heat resistant and has less creep than the ordinary steels. Such special tubes will withstand higher temperatures with less loss of strength and tendency to blister. Another is coating the outside of fire tubes with aluminum (calorizing). This thin coating appears to give some protection of the metal against high furnace temperature. It has been used on tubes of Mercury boilers and is employed sometimes on superheater and fire row tubes. The most obvious thing, however, is to maintain the water or steam surface clean and absolutely clear of all deposits. This is secured by having a smooth interior surface and by suitable chemical treatment of the boiler water.

Associations

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Assistant Chief Inspectors—J. M. Hall, Washington, D. C.; J. A. Shirley, Washington, D. C.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Assistant Director—D. N. Hoover, Jr., Washington, D. C.

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Assistant International President—J. N. Davis, Suite 522, Brotherhood Block, Kansas City, Kansas.

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OFFICE OF INDUSTRIAL RECOVERY COMMITTEE, 15 PARK ROW, NEW YORK

Manager—James D. Andrew.

Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President—Murrel J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

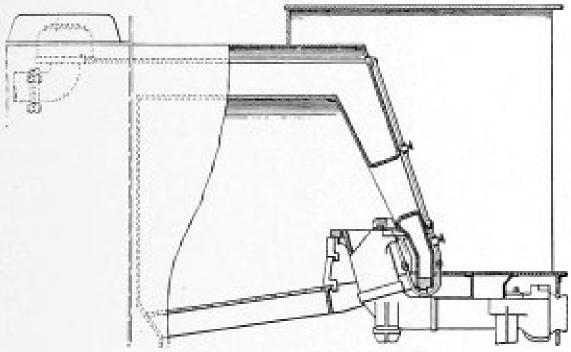
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent Attorney, 1372-1376 National Press Building, Washington, D. C. Readers wishing copies of patents or any further information regarding any patent described, should correspond directly with Mr. Galt.

1,881,215. STEAM SEPARATOR. LOREN P. MICHAEL, OF ELMHURST, ILLINOIS, ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

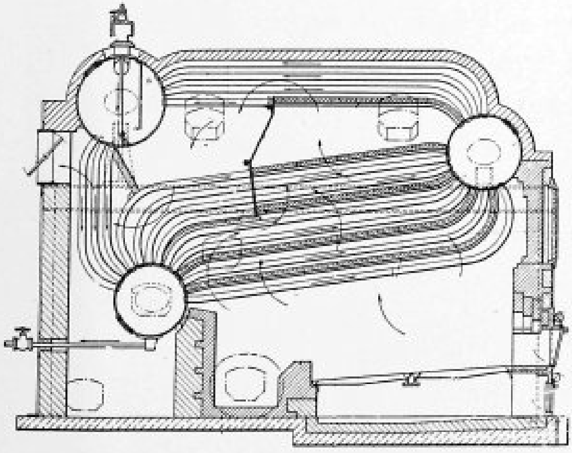
Claim.—In apparatus of the class described the combination of a boiler having a steam space and a water space, a pipe to conduct steam from



the steam space, a steam separator through which the steam flows and in which water is separated out from the steam, a steam operated device transforming heat energy of steam into mechanical energy and capable of using relatively very wet steam, and means to conduct said water from the separator mingled with steam to said device. Six claims.

1,880,350. WATER TUBE BOILER. IVAR L. LANGVAND, OF BARBERTON, OHIO, AND HOWARD J. KERR, OF WESTFIELD, NEW JERSEY, ASSIGNORS TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

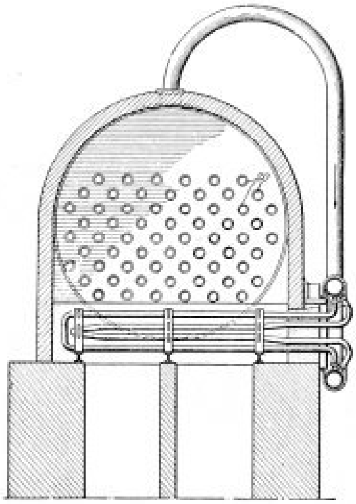
Claim.—In a low head water tube steam boiler, a furnace, a steam offtake drum, a submerged intermediate drum located below the water level of the offtake drum and at the opposite side of the furnace, horizontally arranged steam circulators leading from the top of the inter-



mediate drum to the steam space of the offtake drum and constituting the only direct connection between those two drums, a lower drum positioned at the offtake drum end of the furnace, a main bank of inclined steam generating tubes forming the roof of the furnace and directly connecting the lower and intermediate drums, and a bank of water circulator tubes directly connecting the offtake drum and the lower drum so that the horizontal distance between the drum centers of the main bank of tubes is much greater than the vertical distance, the steam circulators constituting a steam pass in which the steam generated in the main bank of tubes is subjected to drying action on its way to the offtake drum, the tubes of the water circulator bank being bent away from a line connecting the centers of the offtake and lower drums to provide a lower drum tube seat portion extended at the top of that drum for the securement of the bent ends of the tubes of the main bank therein. Four claims.

1,881,815. WASTE GAS SUPERHEATER. LEO A. MEHLER, OF EAST CHICAGO, INDIANA, AND ELLSWORTH J. WESTCOTT, OF CHICAGO, ILLINOIS, ASSIGNORS TO FREYN ENGINEERING COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF MAINE.

Claim.—The combination of a waste gas boiler having tubes extending longitudinally therethrough, being adapted to have said tubes blown from



the front end, and having an inlet flue at the front end; with a waste gas superheater in said flue comprising headers located at the side of said boiler and pairs of horizontally extending pipes in front of said boiler, the two pipes of each pair being U-shaped and connected in a single radial plane to each header, said headers being sufficiently separated so that the U-shaped pipes may be withdrawn between said headers while retained in their original planes.

Boiler Maker and Plate Fabricator

National Board Meeting

The tenth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors, held in Chicago, May 14 to 17, proved to be one of the most outstanding in the history of this organization both from the standpoint of attendance and in the scope of the program.

It was planned to commence publication of the complete report of the meeting in this issue, but, due to delay in receiving the transcript of the papers and discussion, publication of the first instalment has been deferred until the July issue.

Master Boiler Makers' Business Meeting

The Association of American Railroads has granted permission to the mechanical associations not included in its organization to hold business meetings in Chicago in September. Four of the co-ordinated associations will hold meetings on September 16 and 17. The Master Boiler Makers' Association, the American Railway Tool Foremen's Association, the International Fuel Association and the International Railroad Master Blacksmiths' Association are scheduled to meet Wednesday and Thursday, September 18 and 19.

Most of these associations will undoubtedly take advantage of the opportunity thus offered, and to this end will prepare programs of interest to their membership. Such plans are now going forward with the Master Boiler Makers' Association. Every effort will be made to bring together at this business meeting all officers, committee members and as many of the membership as can obtain authorization to attend.

A special program of papers based on outstanding developments in the locomotive boiler field during the past four years is now in process of preparation. Radical changes in railroad operating methods and equipment, the possibility of improved tools and facilities, the pressing problems involving personnel—all these demand study and discussion by key men from the boiler departments of every railroad of the country.

It is essential that the program covering conditions within this department be of such character that mechanical officers generally will feel it necessary to send their men to the meeting in order that they may learn of the latest practices in locomotive boiler construction and maintenance.

It is definitely within the power of the officers through the medium of this brief business meeting to revive the activities of the Master Boiler Makers' Association and to establish its future on a sound and useful basis. If this is done, there can be no question of obtaining the support of mechanical officers for its work. The prestige held by the association in the past throughout the railway field is the groundwork from which the master boiler makers must advance to a new period of usefulness. This can only be accomplished through untiring effort on the part of officers and members in preparing for the business meeting in September. If the results obtained are commensurate with the capabilities of this organization, the future of the association will rest secure. Support for its activities may then be expected from mechanical officers and from the Association of American Railroads, for all its future conventions.

Service on Designing Boiler Patches

A new service is being established at this time in connection with the Questions and Answers Department; namely, assistance in boiler patch design. The announcement of this service, and an outline of requisite information to be supplied by those desiring help in this connection, appears on page 169.

Some few of the larger railroad systems have established central design departments in recent years, through which all questions concerning locomotive repair procedure are cleared. For example, any boiler shop on an entire system, working under such arrangement, may obtain a prompt check on the details of any boiler patch which it is desired to apply.

Most roads are not so happily situated, however, and the question of properly designed boiler patches is a more or less troublesome one. It is with the idea of assisting those concerned with installing suitable patches, who may have no ready means of checking their work, that this service is being inaugurated.

All such questions may be sent to this office with the necessary data outlined in the announcement, and every effort will be made promptly to check the proposed patch to meet the service requirements or to make such corrections and suggestions as will adapt it to this purpose.

Do not hesitate to take advantage of this service.

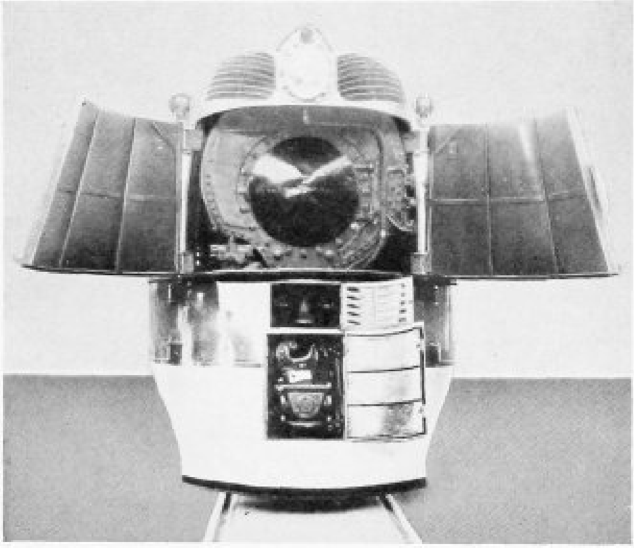
Recovery in the Boiler Industry

As was to be expected, the forty-seventh general meeting of the American Boiler Manufacturers' Association and Affiliated Industries, reported in this issue, was centered on ways and means of continuing recovery of this representative heavy goods industry without the benefits it enjoyed under NRA operation. Never in the history of the organization has the registration indicated a wider interest in its activities. Substantial gains had been made during nearly two years of code administration and every effort is being expended by the industry to consolidate the gains for the future.

In furtherance of this objective a committee of fair practice has been appointed to draft and submit as quickly as possible to members of the industry for signature a code of business ethics. The basis of policy will unquestionably be that of fair relations with those employed in the industry already established under NRA, and the continuation on an ever wider scale of the methods of fair competition that have brought substantial recovery to the industry.

Boiler for Milwaukee

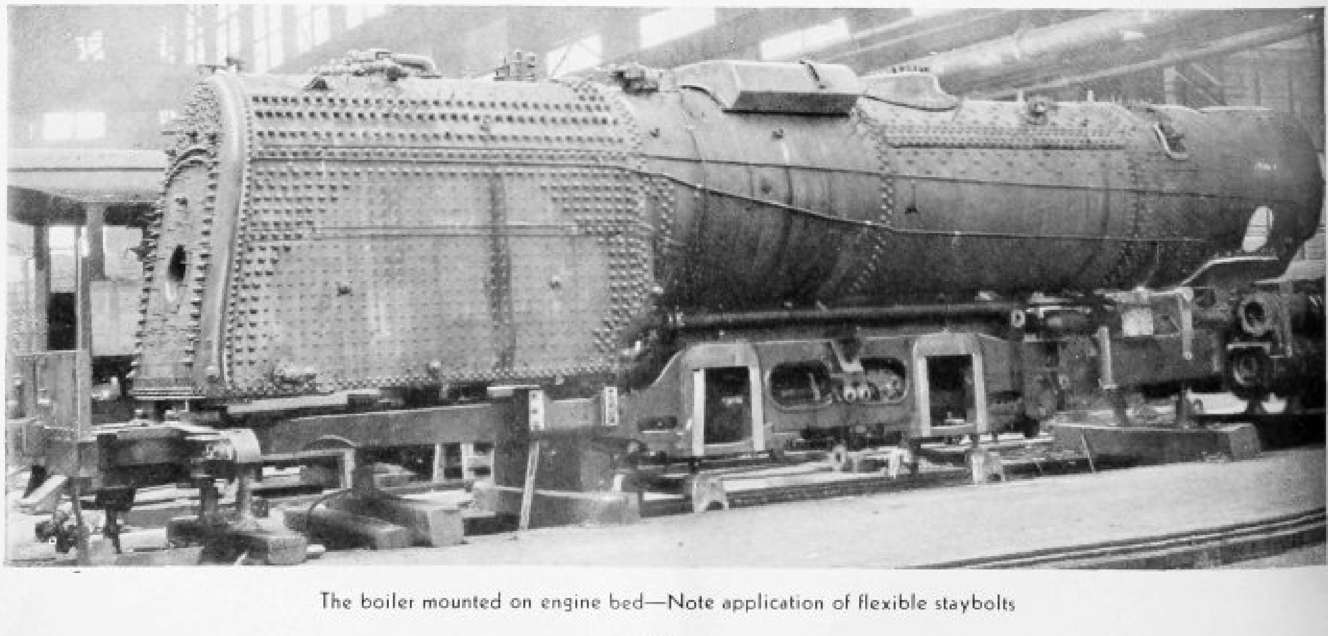
STREAMLINED LOCOMOTIVE



Front doors and grille opened for access to front end, coupler and bell

Two high-speed streamlined passenger locomotives of a new and strictly modern design were delivered to the Chicago, Milwaukee, St. Paul & Pacific in May by the builder, the American Locomotive Company. These locomotives were designed to haul the new "Hiawatha" trains on daylight runs between Chicago and the Twin Cities, 410 miles, with five intermediate stops, on a six and one-half hour schedule—an average start-to-stop speed of 63.1 miles per hour or an average running speed of 66 miles per hour. These trains of six cars each weigh 340 tons, exclusive of passengers and baggage. All cars are of new design and built by the road for this service. One of the locomotives, on a trial trip before being placed in service, made the run from Milwaukee to New Lisbon, 141 miles, in 113 minutes, or at an average speed of 74.9 miles per hour. The maximum speed reached was 111.5 miles per hour. On the return trip the train, consisting of the locomotive, a dynamometer car, and five coaches, was stopped from a speed of 100 miles per hour in 6600 feet.

A striking and pleasing appearance was obtained by shrouding the upper portion of the locomotive and using a partial skirting below the running boards, this skirting being extended downward at the front to replace the pilot. No attempt was made to conceal the running gear. The smooth appearance and clean lines are enhanced by the color scheme adopted for the locomotive and tender and by a touch of appropriate ornamentation at the front end. The finish includes black, gray, orange yellow, maroon and brown, with lettering in gold leaf and the conventionalized Indian headdress on the shrouding front in polished chromium. In arranging the shrouding and skirting to permit ready access to all concealed apparatus great care and ingenuity were exercised to keep the exterior surfaces free from bolt heads, nuts or other projections.



The boiler mounted on engine bed—Note application of flexible staybolts

View of the Milwaukee locomotive before the shrouding was applied

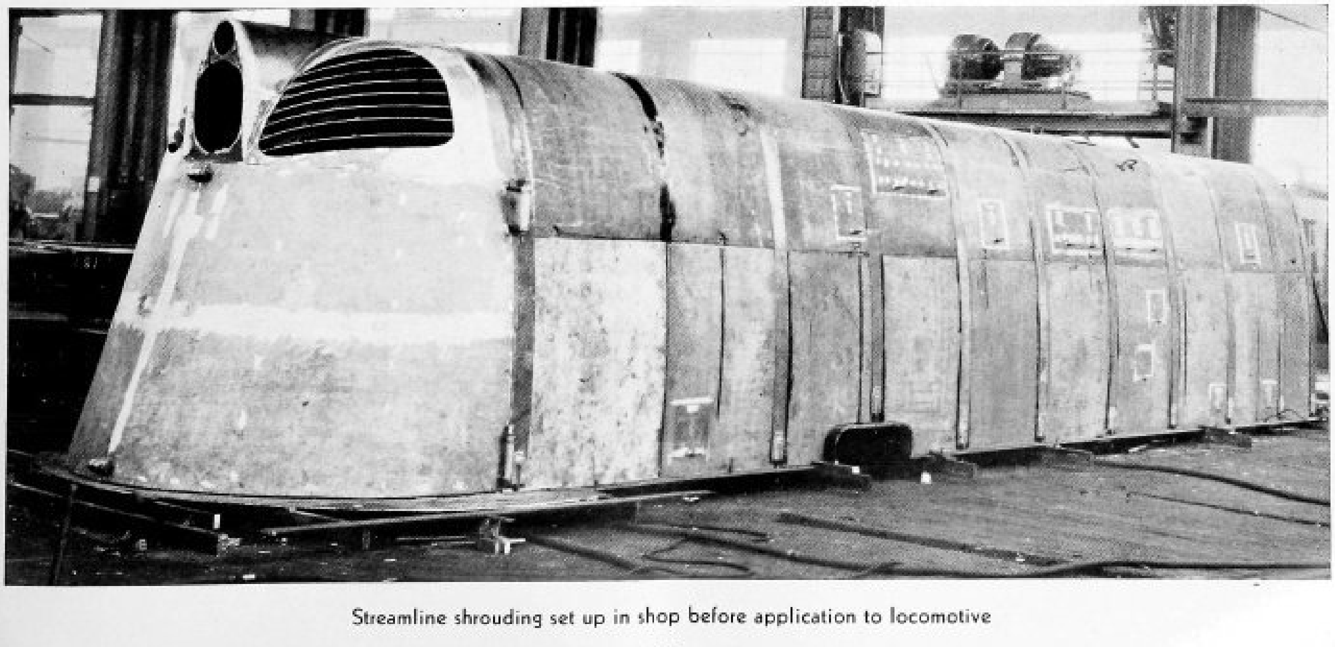
These locomotives are of the 4-4-2 type; weigh 280,000 pounds, of which 140,000 pounds is on the drivers, and have a rated tractive force of 30,700 pounds. The driving wheels are 84 inches in diameter, the cylinders are 19 inches by 28 inches, and the oil-fired boiler carries a pressure of 300 pounds per square inch. The boiler is of such size and capacity as to enable the steam to be supplied over extended periods for speeds in excess of 90 miles per hour.

The boiler is of the straight-top type, embodying a conventional stayed firebox and firetube shell. The barrel is rolled in two courses, the dome being located on the forward course, 7 feet back from the front tube sheet. The front shell course is $^{13}/_{16}$ inch in thickness and has an inside diameter of $79^{11}/_{16}$ inches. The second and larger shell course, which is 80 inches in diameter outside, is rolled from plate $^{27}/_{32}$ inch in thickness. The boiler shell courses, including the welt strips and the firebox wrapper sheets, are of Lukens silicon-manganese steel.

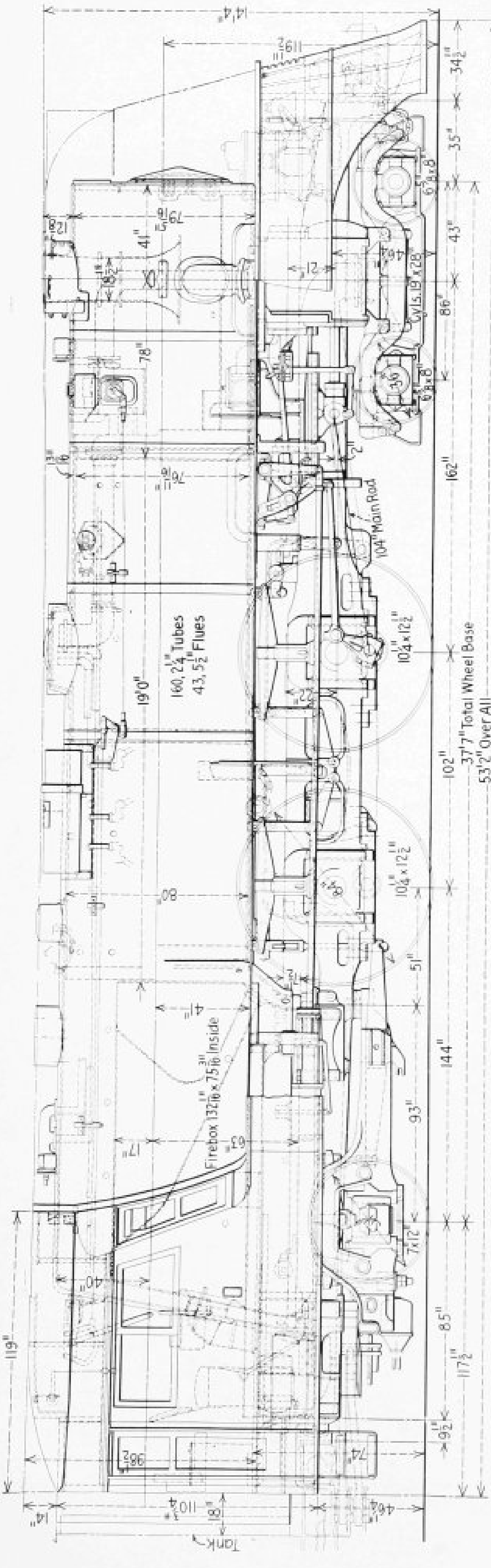
The firebox sheets are of Lukens homogeneous firebox steel, built up on a cast-steel mudring. In length the firebox is $132^{1}/_{16}$ inches, $75^{3}/_{16}$ inches wide inside the sheets. At the front the water space is 5 inches, while at the sides and back the space is decreased to $4\frac{1}{2}$ inches. Firebox crown and side sheets are rolled in one piece of $^{13}/_{32}$-inch plate. The back head is $^{3}/_{8}$-inch plate and the tube sheet $^{9}/_{16}$-inch thick.

The firebox is of welded construction throughout, with butt-welded seams. Welding is also used for 12 inches from the ends along the longitudinal shell seams and the edges of the wrapper sheets are welded at all corners 12 inches up from the bottom of the mudring. Both the firebox and wrapper sheets are also seal welded to the mudring behind obstructions which would make access for calking difficult.

There are 160 tubes, $2\frac{1}{4}$ inches in diameter, and 43 flues, $5\frac{1}{2}$ inches in diameter, the length over tube sheets being 19 feet. The firebox on its measurement of $132^{1}/_{16}$ inches by $75^{3}/_{16}$ inches inside provides an equivalent grate area of 69 square feet. The combined heating surface is 4274 square feet, of which 294 square feet is in the firebox and syphon, 2951 square feet in the tubes and flues, and 1029 square feet in the Type A superheater. The gas area through the tubes and flues is 1078 square inches and the area under the table plate in the smokebox is 1770 square inches. A Nicholson thermic syphon is fitted in the firebox.



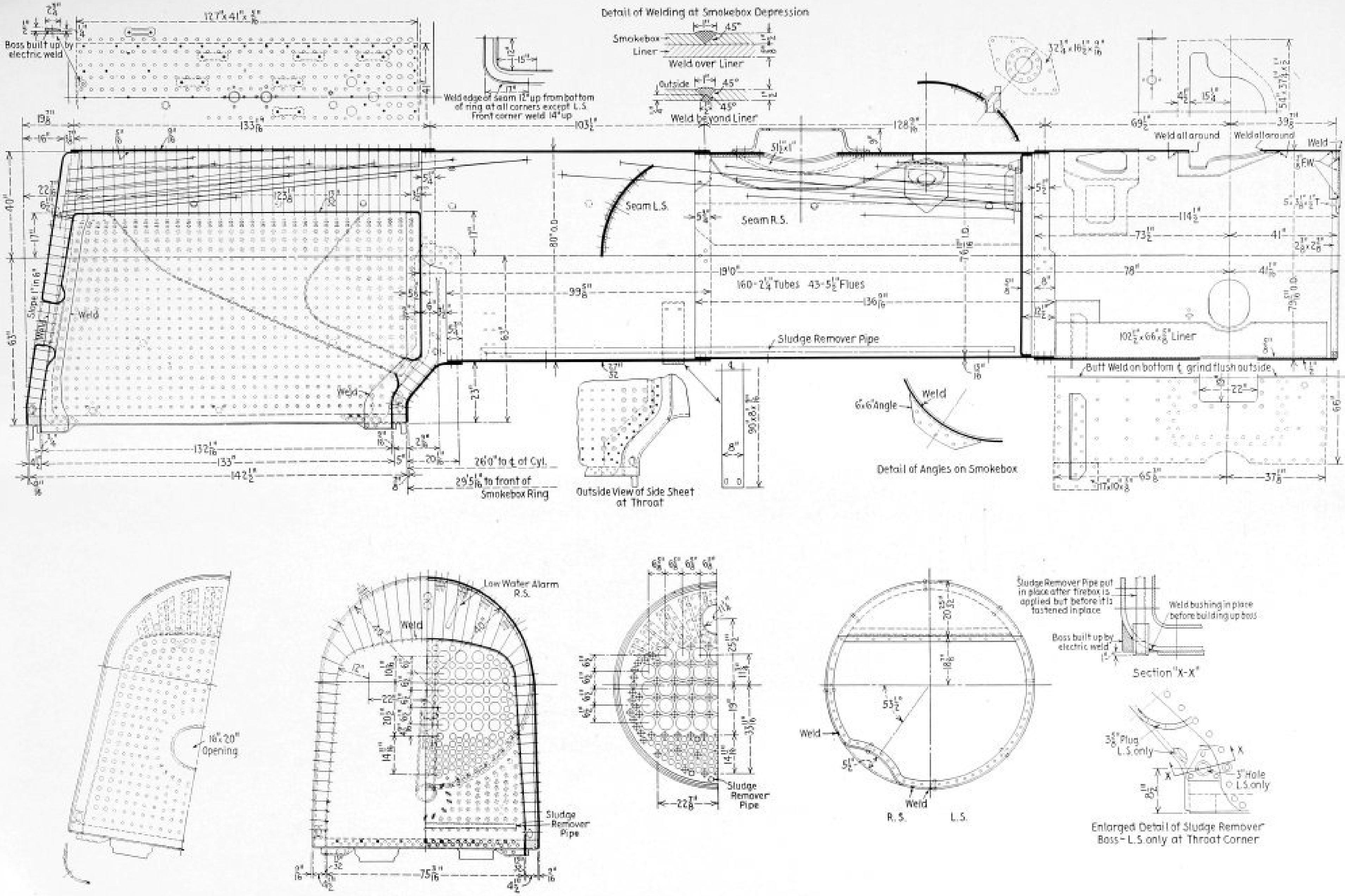
Streamline shrouding set up in shop before application to locomotive



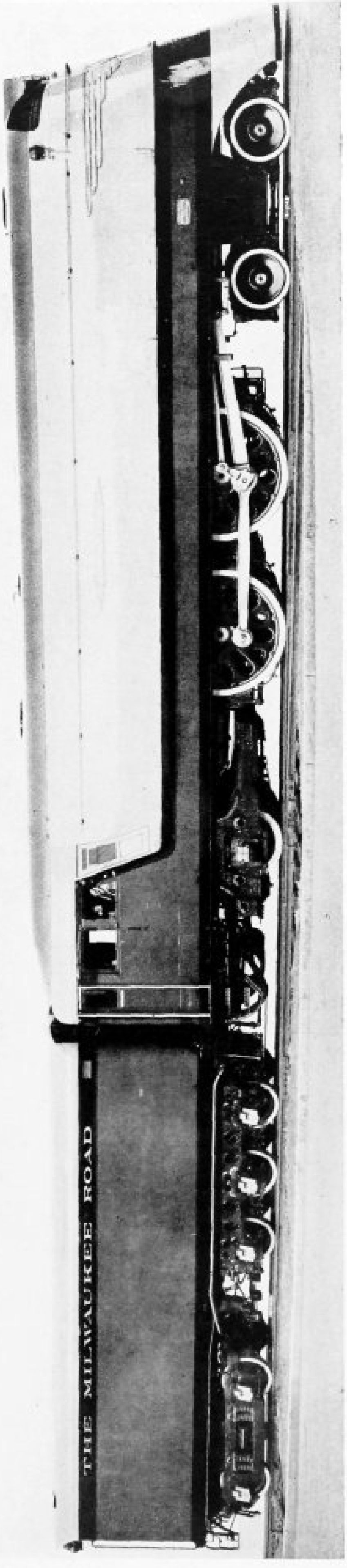
Elevation of the Chicago, Milwaukee, St. Paul & Pacific high-speed streamlined locomotive

Principal Dimensions, Weights and Proportions of the C. M. St. P. & P. Streamlined Locomotives

Railroad	C. M. St. P. & P.
Builder	American Locomotive Co.
Type of locomotive	"Hiawatha" 4-4-2
Road numbers	1-2
Service	High-speed pass.
Height to top of stack	14 ft. 4 in.
Width	10 ft. 2⅝ in.
Cylinders, diameter and stroke	19 in. by 28 in.
Valve gear, type	Walschaert
Valves, piston type, size	10 in.
Maximum travel	6½ in.
Steam lap	1⅛ in.
Exhaust clearance	¼ in.
Lead	¼ in.
Cut-off in full gear, per cent	85
Weights in working order:	
On drivers	140,000 lb.
On front truck	75,000 lb.
On trailing truck	65,000 lb.
Total engine	280,000 lb.
Tender	247,500 lb.
Wheel bases:	
Driving	8 ft. 6 in.
Total engine	37 ft. 7 in.
Total engine and tender	78 ft. 10½ in.
Wheels, diameter outside tires:	
Driving	84 in.
Front truck	36 in.
Trailing truck	51 in.
Journals, diameter and length:	
Driving, both axles	10¼ in. by 12½ in.
Front truck	6⅝ in. by 8 in.
Trailing truck	7 in. by 12 in.
Boiler:	
Type	Straight-top
Steam pressure	300 lb.
Fuel	Oil
Diameter, first ring, inside	76 11/16 in.
Diameter, largest, outside	80 in.
Firebox, length and width	132 1/16 in. by 75 3/16 in.
Height mud ring to crown sheet, back and front	80 in.
Syphons	One
Tubes, number and diameter	160—2¼ in.
Flues, number and diameter	43—5½ in.
Length over tube sheets	19 ft. 0 in.
Total gas area through tubes and flues	1,078 sq. in.
Grate area	69 sq. ft.
Heating surfaces:	
Firebox and comb. chamber	254 sq. ft.
Syphon (1)	40 sq. ft.
Firebox, total	294 sq. ft.
Tubes	1,781 sq. ft.
Flues	1,170 sq. ft.
Tubes and flues	3,951 sq. ft.
Total evaporative	3,245 sq. ft.
Superheating (Type A)	1,029 sq. ft.
Combined evap. and superheat	4,274 sq. ft.
Water conditioner	Wilson
Tender:	
Style	Built-in fuel tank
Water capacity	13,000 gal.
Fuel capacity (oil)	4,000 gal.
General data estimated:	
Rated tractive force, 85 per cent	30,700 lb.
Speed at 1,000 ft. piston speed	53.55 m.p.h.
Piston speed at 10 m.p.h	186.5 ft. per min.
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	50
Weight on drivers ÷ tractive force	4.56
Total weight engine ÷ comb. heat. surface	65.5
Boiler proportions:	
Tractive force ÷ comb. heat. surface	7.18
Tractive force × dia. drivers ÷ comb. heat. surface	603
Firebox heat. surface, per cent. comb. heat. surface	6.87
Tube and flue heat. surface, per cent comb. heat surface	69.05
Superheat. surface, per cent comb. heat. surface	24.08
Firebox heat. surface ÷ grate area	4.26
Tube and flue heat. surface ÷ grate area	42.77
Superheat. surface ÷ grate area	14.92
Comb. heat. surface ÷ grate area	61.94
Gas area, tubes and flues ÷ grate area	0.109



Longitudinal and transverse sections of the boiler of the Milwaukee 4-4-2 type locomotive



This streamlined steam locomotive of the Milwaukee ushers in a new era in motive power possibilities

All stays in the firebox are of Lewis special staybolt iron. The installation made up of 1-inch, $1\frac{1}{16}$-inch, and $1\frac{1}{8}$-inch diameter stays includes a liberal application of flexible stays in the breaking zone. There are 651 flexible water space stays applied; 111 in the throat and 102 in the back head; none of these are welded. In the sides 438 stays are applied of which 66 are welded.

Flexible expansion stays total 48, having welded sleeves. A total of 120 radial stays with welded sleeves are applied. Rigid radials number 322; and solid stays 1121. The solid stays are located as follows: 21 in the throat, 260 in the back head, and 840 in the sides. Of this total of 1121 solid stays, 884 are rigid, and 236 hollow.

The locomotive is equipped with a Wilson water-conditioner, feed pump, sludge remover and blow-off cocks. A Hancock Type W non-lifting injector is also provided. The Hancock boiler feed check valves are located on the upper quarters midway between the dome and the front flue sheet. Washout plugs are of the T-Z pattern. A Barco low-water alarm is also included. Firebrick was supplied by the American Arch Company.

The sludge remover installation includes one air-operated blow-off cock in the belly of the boiler, connected to a sludge pipe in the barrel and discharging into the muffler. It is operated from the cab by a valve on the engineer's side. A similar air-operated blow-off cock, operated from the fireman's side of the cab, is located in the left front corner of the firebox. It connects with a sludge pipe in the front water leg and discharges into the muffler.

A total of 32 washout plugs is so arranged that boiler washing can be carried out conveniently; their locations are indicated on the boiler drawings, page 147. Of the total, 23 plugs of the square-thread type are $2\frac{1}{2}$-inch size; 4 plugs in the front flue sheet are $2\frac{15}{32}$-inch size; 1 drain plug in the bottom of the smokebox 2-inch size; and 4 corner plugs above the mudring are $2\frac{7}{8}$-inch.

The boiler is supported on sliding shoes at both the front and back ends of the firebox. Between the driving wheels and at the guide yoke are waist sheets which have sliding fits on the boiler shell.

Instruction for Fabricating Boiler

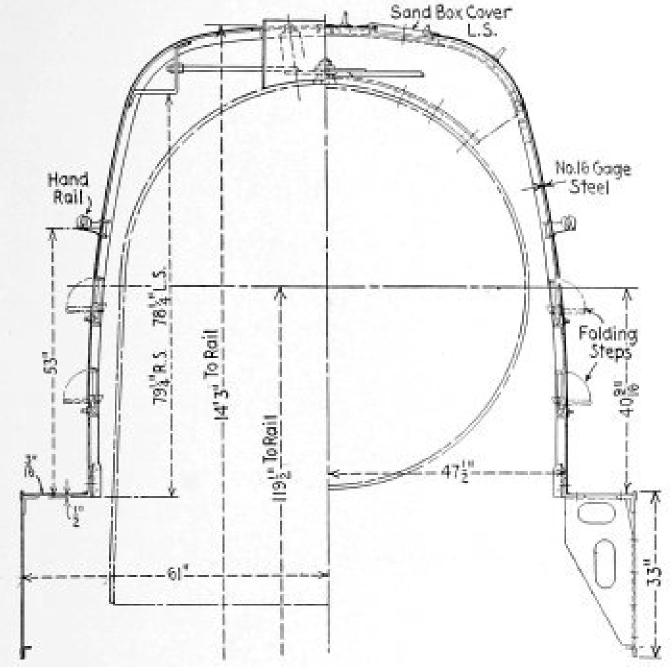
Before considering other general features of this locomotive, a brief reference to instructions on boiler work, as outlined in the specifications, will indicate the care with which this boiler was fabricated. While many of the details conform with customary practice, a statement of the requirements will be of interest.

Fusion welding under the specifications was not permitted except as authorized by decisions of the chief inspector, Bureau of Locomotive Inspection. Conforming with this, welding was used on the first course and on the second course seams for a distance of 12 inches at the front and back. All sheets were beveled along the calking edge on the outside and fuller calked inside and out. The firebox was of welded construction and the mudring corners were welded for tightness where the sheets joined as previously mentioned.

Shell courses when assembled were required to be perfectly round with all sheets laid up to a tight fit and planed at the edges. All parts of the boiler were designed to conform with I.C.C. requirements. Circumferential seams were made interchangeable for the two locomotives constituting the order.

The main steam dome was pressed from a single sheet of open-hearth steel. The dome caps also were of pressed steel and sufficiently thick to prevent springing.

The water space frame was specified as cast steel grade



Section through shrouding and skirting

B medium, free from flaws and imperfections and machine finished on all sheet faces. Water space frame corners have a radius of 3 inches on the inside and 7¼ inches on the outside. This frame was not slotted out to the full thickness of the sheets but the latter were scarfed to fit the contour of the frame.

In cutting tube and flue holes, these were center punched not to exceed 1 inch in diameter and finished true with the rotary cutter, exactly to specified size. All tube and flue holes were smooth finished, the edges being chamfered to a radius of ⅟₁₆ inch on both sides to remove sharp edges.

The tubes and flues were required to be completely straight and true before placing in the boiler. Both ends were annealed and swaged at the back end to fit into copper ferrules. All scale was removed from both ends by a file or by grinding after swaging the back end. Copper ferrules, of course, were used only in the back flue sheet. In applying, the tubes extended ¼ inch and flues ⅜₁₆ inch through the front and back tube sheets for beading. They were peened and flared in two places to hold them in position in the back flue sheet before rolling in with a roller expander. After rolling at the back end, the flaring tool was used and finally the tubes were expanded with a prosser expander. In expanding, the pin was driven into the expander until the tubes and flues were tight against the sheets. This was repeated three times, each time turning the expander slightly. At the front end, the tubes and flues were rolled tight in the sheet with the roller expander then flared with a flaring tool. All tubes and flues in the superheater zone and 10 percent of the balance were beaded over at the front and all of them at the back end. After the tubes and flues were beaded and driven up tight on the first fire test, they were carefully cleaned at the back tube sheet and the beads sealed by electric welding.

For applying rivets and studs, all holes in the boiler and firebox plate were drilled ⅟₁₆ inch small and burrs then removed. After sheets were properly fitted and bolted together, the rivet holes were reamed not to exceed ⅟₁₆ inch above the size of the full rivet. The use of drift pins was not permitted. The rivets were driven to fill all holes completely. Countersinking where required was done after the holes were reamed and then in perfect alinement with the holes.

Wherever possible the rivets were driven by hydraulic pressure and in these cases the pressure was maintained on the rivet not less than five seconds after being driven, then released and the next rivet driven in the same manner. After the pressure was released on the second rivet, the rivet previously driven was subjected again to pressure for not less than three seconds.

Staybolts and radial stays met the requirement of 12 U. S. formed threads per inch and were accurately fitted to corresponding threads cut in the sheets. The maximum allowable stress per square inch of cross sectional area on staybolts and stays was 7500 pounds. Holes for staybolts and radial stays were drilled ⅟₁₆ inch small and reamed to size for the full thickness of the sheet. In no place in the firebox sheets does the pitch of stays and staybolts exceed 4 inches from center to center. All rigid staybolts were of a snug fit with full threads contacting entirely through both sheets, each end projecting not less than three full threads for hammering over. Rigid staybolts were countersunk on the outer end. The first row of staybolts above the water space ring and all around were drilled hollow stays 1 inch in diameter. Hollow drilled staybolts also were applied behind the arch bricks and at all other places where parts might conceal them, as in the case of running board brackets, fire door frame, protecting grate and the like. All hollow bolts were drilled ⁷⁄₃₂ inch for their full length.

As required by regulations, the boiler was first tested with warm water at about 150 degrees F. In this first test the pressure was raised by means of the injector pump to a point 25 percent above that for which the boiler was designed. While under pressure all leaks were stopped.

During the first steam test, 100 pounds of soda ash were used for boiling out purposes. The pressure was raised under this test to 325 pounds per square inch, at which point all apparent leaks were stopped. After reducing pressure to atmospheric, the boiler and firebox sheets were thoroughly washed.

A second steam test following the same procedure as in the first, using soda ash for boiling out, was required. All leaks that developed were calked. During each test the pressure was raised gradually to 325 pounds per square inch over a period of not less than 3 hours. The second test was conducted a day later than the first.

After the second test, all washout plugs were removed and the boiler and firebox sheets thoroughly washed and the final blow-down carried out before the engine was shipped. The boiler washing was done with hot water and sufficient pressure to clean all sheets.

The Front End

An unusual feature of the front end is the exclusion of the volume in front of the diaphragm and above the table plate from the smokebox proper. The table plate which extends forward to the smokebox front is provided with an opening to which the bottom of the stack extension is fitted. Since the fuel is oil, no front-end screen is needed. The exhaust nozzle is relatively low, the Goodfellow tip standing 19⅞ inches from the bottom of the smoke arch and 12⅛ inches below the bottom of the stack extension and table plate. The smokestack has a diameter of 18½ inches at the choke and a total height of 60³⁄₁₆ inches, the top being 14 feet 4 inches above the rail.

Advantage has been taken of the fact that the smokestack is concealed to use it as a support for the streamline shrouding, the necessary bolting lugs being cast on it, both in front and at the rear. A vertical passage of circular section which extends up to the top of the stack also forms an integral part of the casting at the rear. This is provided with a suitable connecting flange at the base and serves as an exhaust pipe for the feed-water pump and the turbo-generator. The moisture from these exhausts is thus kept out of the smokebox. Grilles at the top of the front of the shrouding admit air to a duct which has an outlet behind the stack where it serves as a smoke lifter. The entire front end is lagged and jacketed to keep down the temperature inside the shrouding. The smokebox front is swung on Okadee hinges.

The rectangular tender is built up by welding upon a General Steel Castings water-bottom frame. As it is designed to be used in oil-burning service only, the fuel tank is built integrally. The hot water compartment of the Wilson water conditioner is located on the left side of the water tank at the front and receives exhaust steam from the back end of the cylinder exhaust ports through pipes which are carried between the frames and under the draft pan to the tender.

The top of the tank is shrouded to conform with the contour of the roofs of the new cars with which these locomotives will be operated. A single opening in this shrouding provides access to both water and oil-filling holes. The rear end of the tender is fitted with a dummy vestibule connection. The tank has a water capacity of 13,000 gallons, and a fuel oil capacity of 4000 gallons.

Since the locomotive and tender are built for oil-burning service only, there was no need for access to the tender through the arch at the rear of the cab. The back of the cab has, therefore, been completely enclosed and provided with side doors. The cab is of welded construction with one thickness of American hair felt insulation between the outside sheets and the inside wood lining.

There are two steam turrets. That for superheated steam is located on the smokebox near the superheater header and supplies steam for the air pump, the turbo-generator, the blower line, the oil burner and the cylinder cocks. The saturated-steam turret is placed in the conventional location just ahead of the cab and supplies the injector, steam heat for the train and cab, the power reverse gear, the feed-water pump and the lubricator heater.

Streamline Shrouding

The shrouding completely encloses the boiler and all apparatus customarily suspended from the boiler or mounted on the locomotive bed. Extending down to the running board, it is built of No. 16 gage material—Toncan steel for the doors ahead of the smokebox and Republic double-strength steel for the remainder. The sheets are carried on a frame consisting of angle carlines which are supported from the running boards and braced to the top of the boiler. The shrouding is fitted with doors, opposite all washout plugs, sand traps, boiler checks, etc. The entire front is enclosed in swinging doors, the opening of which gives access to the front end and the equipment mounted on the front deck.

Among the interesting details of the shrouding are folding steps in the sides which can be let down when access to the sand box or cab turret is desired. The classification lamps are supported on top of the upper hinges of the front shrouding doors and these hinges have been designed so that the wiring is carried through them to the jacket. The handrail columns are fitted with simple spring latches, by means of which the handrail is securely locked in the columns. Each is unlocked by a push button and opened by spring torsion. Closing the latches automatically locks them in place. An entire side section of the handrail can thus be removed and replaced in a few minutes without the use of tools.

The lower section at the front end of the shrouding serves as a pilot. This is a stiff, welded structure of plates and angles which extends from below the bottom of the front-end shrouding doors. A panel on the center of the pilot conceals the coupler when it is not in use. The coupler is hinged in its pocket to swing upward and when its use is required, on removal of the panel, it can be swung down horizontally. Train-brake and air signal lines are carried to the front of the locomotive, where they terminate inside the shrouding with standard cut-out cocks. The air hose, when not in use, are removed and carried in the concealed tool box.

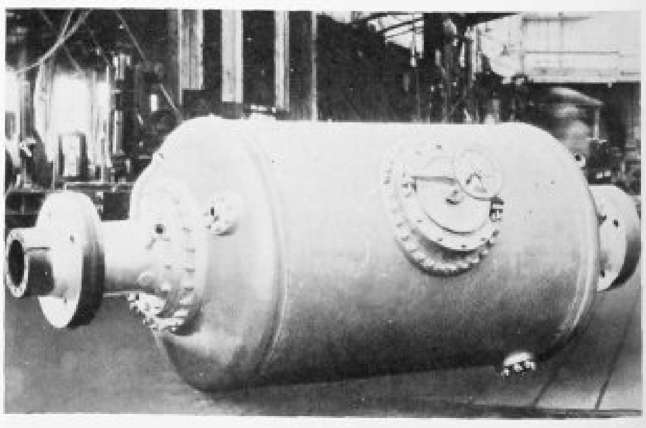
The skirting is supported from the outer edge of the running boards and extends down about 33 inches. This conceals the reverse gear, the boiler feed pump, the spring rigging and most of the valve motion, and forms an unbroken line from the rear of the pilot to the rear of the tender.

Cooker Fabricated of Stainless Clad Steel

Waterous Limited of Brantford, Ontario, have recently secured from a large cereal manufacturer an order to construct a second cereal cooker of stainless clad steel. The first cooker of this type was constructed in the fall of 1933, and was a radical departure from building these cookers of ordinary mild steel, as had been the former practice.

The cookers, approximately 6 feet long by 4 feet in diameter are of the revolving type, the cereal being cooked by live steam in the presence of salt. In an effort to secure added sanitation and longer life, stainless clad steel was specified as a trial unit.

After more than a year in service the cereal manufacturer has now ordered a duplicate unit to be constructed of the same material, IngAclad 18-8 stainless clad steel as produced by the Ingersoll Steel & Disc Company Division of Borg-Warner Corporation, Chicago. The combination of wet cereal, salt and steam has shown no corrosive action on these cookers having a complete stainless interior surface. The cooker shells are of all-welded construction, as shown in the illustration.



Cereal cooker of stainless clad steel

Forty-Seventh Meeting of

BOILER MANUFACTURERS

With over 100 members and guests registered on June 10 at The Lodge of The Skytop Club, Skytop, Pa., to attend the forty-seventh annual meeting of the American Boiler Manufacturers' Association and Affiliated Industries, President Owsley Brown of the Springfield Boiler Company, Springfield, O., opened what was destined to be one of the most vital meetings in the history of the organization. The meetings of various groups within the convention continued from June 10 to 13, and were mainly devoted to the formulation of emergency measures, made necessary by the disruption of the machinery set up by the National Industrial Recovery Act for the conduct of the business of boiler manufacturing under its Code Authority.

This industry was one of the first to adopt a code of fair competition and was probably the first industry of less than major importance to have the code approved. Under the able direction and management of James D. Andrew, manager of the A.B.M.A. & A.I. Code Authority and with the assistance of H. E. Aldrich, his assistant, the boiler manufacturing industry had in the course of nearly two years made substantial progress towards recovery The recent Supreme Court decision, too well-known to require discussion, which vitiated completely all NRA administrative activities, has been a real blow to this industry.

It was with the earnest desire of establishing measures which would not only carry on the purposes and beneficial provisions of its official code, but to advise the industry still further on the road to recovery with a more permanent policy along the same lines, that the membership devoted practically all of its time in executive session.

General Business Session

Matters of routine and general business were quickly disposed of by the president at the opening session on June 10. In the annual address of the president, Mr. Brown stated the pressing need for establishing a policy of fair competitive practices, and fair provisions for all labor employed within the industry. All standards established under the codes in these respects are to remain unchanged and unimpaired. His remarks are in part as follows:

Abstract of President's Address

This is the largest meeting that we have ever had in the history of the organization. The secretary tells me that there are over 100 present at this meeting, including members of the association, guests, associate members and their families. The attendance seems to be warranted, because we are about to make decisions that are of vital importance to the industry as a whole.

We have many important things to consider at the executive meeting which will follow the general meeting. We must try at least to form some preliminary plans as to what we shall do in this emergency that has recently arisen because of the Supreme Court decision on N.I.R.A.

A year ago, when we met in this same spot, we were cheered by the fact that the amendment to our Code had been approved in April. We had hopes of an increase in heavy industry purchases, and the volume of business, while far from satisfactory, was producing more pleasing results in the way of reduced losses, mainly because of the reduction in operating expenses and more stable price levels.

We had passed through the preliminary stages of the N.R.A. requirements in the way of changes in wage scale and hours which had at first bewildered the industry, and we had definite hopes of business revival. Above all other contributing factors which were favorable, we had developed a spirit of co-operation among the directly competing members which had never before existed in my own memory, during the many years I have been coming to these meetings. While we were not without differences, no serious division had or has affected our organization.

This picture is now changed, and changed so abruptly that the effect of the recent Supreme Court decision on N.I.R.A. can only be likened to the action of a disruptive earthquake. The codes have fallen; agreements made under Code Authorities as to hours, wages and prices are annulled; but these we expect to maintain. Apparently we stand in the same situation which prevailed when we started out to effect our organization under the N.I.R.A.

One of the best known authorities has stated that some of the results of the passing of N.I.R.A. will include, first, price cutting; second, increased competition; third, wage cutting, and, fourth, increased strikes and labor troubles. Perhaps this is correct, but I cannot feel that it will be the experience of this organization and industry.

Another authority warns us that there will be a further decline in general business during July and August. General business conditions we cannot influence, but price cutting and wage cutting are within our own influence. I do believe that this industry will not desire to throw away all the advantages that have attended the efforts put forth by the Code Authority and the various groups who have labored so faithfully and conscientiously for two years past. Can we afford to give up efforts to stabilize our condition and fall back again into a chaotic situation?

Whatever our various political opinions on N.I.R.A. may be, and regardless of whether our original hopes to date were realized or not, I think you will agree that we have gained by the organization we have worked out under its authority; that we cannot give up the advantages we have gained without strenuous effort, and that we must act immediately.

In this group, I am convinced that we have the brains, the will, and the honesty to rise above this emergency and to plan and adopt a new form of action which will operate even more smoothly than our past arrangement.

When we go into the executive session at the end of this general meeting, we have the most important decision to make which has come to us in all the years of the nearly half-century life of the A.B.M.A. And so in closing these brief remarks, may I beg you to throw aside your selfish thoughts of self-interest, and face the emergency with clear thought, patience and consideration of your fellow-members' ideas, but, above all, a faith in the final triumph of honest business in the United States.

Following this address, reports of standing committees were passed upon by the members.

Boiler Code Developments

A. C. Weigel, Combustion Engineering Corporation, New York, chairman of the A.S.M.E. Boiler Code Conference Committee, outlined the important studies and Boiler Code developments that have been made during the past year. Among the standards created and revisions made by the committee are tentative rules involving vessels subjected to external pressure, such as vacuum tanks, inner shell jacketed vessels and the like. Experimental data on this type vessel have largely been collected by the United States Navy in co-operation with manufacturers and the Boiler Code Committee. The rules developed now undergoing study by those interested will undoubtedly soon be promulgated and approved.

Rules on flanges and fittings, flat heads, welded and bolted and riveted heads have been promulgated. In conjunction with the American Society for Testing Materials specifications have been adopted governing ferrous and non-ferrous materials. The Unfired Pressure Vessel Code of the American Petroleum Institute was developed in co-operation with the A.S.M.E. Boiler Code Committee and adopted by the Institute some months ago. Mr. Weigel pointed out that these rules contain numerous beneficial provisions that should be incorporated in the A.S.M.E. Code for Unfired Pressure Vessels, the matter now being under consideration for such changes as are necessary by the Boiler Code Committee.

Revision of Marine Boiler Rules

Another important activity of the committee has been its co-operation with the Bureau of Navigation and Steamboat Inspection in formulating revised rules relating to the construction and inspection of boilers and unfired pressure vessels for marine service.

A. C. Weigel also reported on the excellent work in the interests of the boiler manufacturing industry accomplished during the year by the American Uniform Boiler Law Society of which Charles E. Gorton is chairman. During the past few months, more than 30 bills inimical to uniformity in the construction, inspection, and quality of boilers under the A.S.M.E. code were introduced in legislatures of states and governing bodies of other political subdivisions. These Mr. Weigel reported have all been successfully altered or killed, through the medium of the American Uniform Boiler Law Society. Never in its history has this organization been required to meet so great a demand on its services. The support of every member of the American Boiler Manufacturers' Association should be given whole heartedly to its endeavors.

Feed-Water Studies Curtailed

Because of lack of funds during the past year the studies being conducted on feed water were greatly curtailed, and no formal report of progress on this vital subject could be made. The American Boiler Manufacturers' Association committee on this subject has co-operated to the greatest possible extent in times past with many other organizations sponsoring experimental work to advance a knowledge of feed water and its corrosive and deteriorating effects on boilers and proper treatment to eliminate difficulties in this direction.

In the absence of Carl F. Weigel, Hedges-Walsh-Weidener Company, Chattanooga, Tenn., representative of the A.B.M.A. on the National Board of Boiler and Pressure Vessel Inspectors, A. C. Baker, secretary of the association, read a brief report of the recent annual meeting of the National Board. This was the most successful in its history and as noted elsewhere in this issue will be reported fully beginning in July.

C. O. Myers, secretary of the National Board was in attendance at the boiler manufacturers' meeting.

Listing of Power Boilers in Census Reports

An important change in the manner of listing power boilers in reports of the U. S. Department of Commerce, Bureau of the Census, was discussed. Types of boilers which hitherto have not been listed or subordinated in these monthly reports will be included as major items—and should help materially in giving a clearer picture of the exact status of the various branches of the industry. The committee studying the matter has referred its recommendations to the executive committee and in due course the changes will be approved and submitted to the Census Bureau.

A.B.M.A. Handbook

A 1935 revision has been prepared of the A.B.M.A. Handbook, which is being considered for approval by the membership and should shortly be issued. This book will contain all vital information of the organization and will probably include such changes as may be brought about in the industrial set-up as were developed at the present meeting.

An innovation at this convention was a session devoted to discussion of activities of associate members—a group composed of the supply branches of the industry, including materials, equipment, and the like.

The association as now constituted is divided into the boiler manufacturing group, with separate branches for the watertube boilers, the horizontal return tubular boilers and the steel heating boiler division. The affiliated industries are divided into groups including the superheater branch, the air pre-heater and economizer branch, the pulverizer branch and the stoker branch. The Class 1 welding association group also is affiliated with this association.

Following the general executive session attended by all groups, each branch of the industry devoted its efforts mainly to organizing under the new system in process of development so that no lapse in the trend towards recovery might occur as a result of the Supreme Court N.I.R.A. decision.

To Draft Code of Business Ethics

At the executive session the following resolution was adopted:

> Resolved that the Executive Committee is hereby instructed to appoint, under the provisions of Article VI of the By-Laws, a Committee of Fair Practice to draft and submit to the members of the industry for signature a Code of Business Ethics.

It will be the purpose of this committee to establish a permanent policy that will perpetuate gains made under code administration. The basis will be a continuation of social benefits to those employed within the industry in the matter of hours, wages, settlement of differences and the like. Also of paramount importance will be the continuation of practices providing for fair competition, subscribed to by every member of the industry.

The election of officers was deferred until late in the meeting and was not available when this issue went to press. A report of the election of officers and the list of members registered will appear in a later issue.

A Critical Summary of Published Information on

BOILER-STEEL EMBRITTLEMENT*

By Everett P. Partridge† and W. C. Schroeder†

The particular type of boiler trouble generally characterized by cracking of the plates and rivets along submerged riveted seams has been known for many years as "caustic embrittlement" or simply "embrittlement." This phenomenon has caused more conflict of viewpoints among operating engineers and research investigators than almost any other disease to which boilers are subject. Aside from a discussion of boiler cracking by Hall in 1930, little, however, has been done to correlate the very considerable amount of information bearing on the subject. To supply this deficiency, the authors have collected information on record in the scientific and technical literature which may be significant in understanding embrittlement.

In attempting to organize the material in such way that the broad significance of the various investigations would not be obscured completely by the details, it has been divided into four main parts and a final summary. Since embrittlement involves a selective chemical attack upon steel, the first part has been devoted to a discussion of the chemical reaction between steel and water, including the effect of various dissolved salts. The extent to which chemical attack in the absence of stress affects the mechanical properties of steel is considered in the second part of the survey. Since the mechanical properties of steel at boiler temperatures are not the same as at room temperature, this effect, entirely separate from that of chemical attack, is described in the third part. The fourth part is a review of the effects of combined chemical attack and mechanical stress upon the cracking of steel. The final summary includes suggestions for further experimental work.

The present article, which is intended to serve only as an abstract of the complete review, lists the conclusions reached by the authors from their examination of the more significant papers in the various fields just cited. These conclusions are subject to modification as further experimental work supplies information lacking at present.

Chemical Factors in the Attack of Boiler Waters Upon Steel

Examination of the chemical behavior of unstressed iron in water or various solutions, while not adequate in itself to explain embrittlement, does provide a necessary background for an understanding of the chemical factors in the embrittlement process. The considerations which seem most significant may be summarized as follows:

(1) In the absence of oxygen, water reacts with iron at ordinary or elevated temperatures to produce hydrogen and a coating of black magnetic oxide (Fe_3O_4) on the iron surface.

(2) The oxide coating acts as a mechanical barrier that tends to separate the iron from the water and thus to slow down the rate of reaction.

(3) Various substances in solution tend to destroy or strengthen the oxide coating, thus affecting the rate of reaction. Low concentrations of sodium hydroxide tend to maintain a coating with the greatest protective qualities. Increasing concentrations of sodium hydroxide, disodium phosphate, sodium nitrate, and sodium chloride decrease the protective effect, in contrast to sodium sulphate, which apparently tends to produce a highly protective coating.

(4) When several substances are present in solution, the net effect may differ from that anticipated from the effects of the individual constituents. Thus the protective action of sodium sulphate against attack by sodium hydroxide is offset by the addition of sodium chloride.

(5) Any discontinuities in the oxide coating coating will accelerate localized chemical attack.

Effect of Chemical Attack Upon the Mechanical Properties of Low-Carbon Steel

Because hydrogen is produced inevitably whenever water or an aqueous solution comes in contact with steel, particular attention has been directed to the brittleness produced in steel by dissolved hydrogen. From a consideration of experimental results the following general conclusions are offered:

(1) The normal solubility of hydrogen in iron over the range of boiler temperatures is estimated to be very low. The solubility in general increases with temperature and pressure.

(2) Quantities of hydrogen greatly in excess of the ordinary solubility may be absorbed by steel during chemical reaction at the surface of the metal, the hy-

* Published by permission of the Director of the U. S. Bureau of Mines. This article is an abstract of a detailed study, presented at the Annual Meeting, New York, N. Y., December 3 to 7, 1934, of The American Society of Mechanical Engineers, in connection with an investigation conducted under a co-operative agreement between the Joint Research Committee on Boiler Feedwater Studies and the United States Bureau of Mines. The general investigation is supervised by a subcommittee of which J. H. Walker is chairman, and is carried out at the Nonmetallic Minerals Experiment Station of the Bureau of Mines, maintained in co-operation with Rutgers University at New Brunswick, N. J. The interpretations and comments are those of the authors, and the summary as a whole is to be regarded as a report to the subcommittee rather than by the subcommittee.

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drogen diffusing readily into the metal as if it were under an extremely high gas pressure.

(3) Hydrogen absorbed by steel during chemical reaction at the metal surface diffuses out of the steel when the chemical reaction ceases.

(4) The rate of diffusion of hydrogen through steel, both into the steel during chemical reaction at the metal surface and out from the steel after reaction has stopped, increases with temperature.

(5) Steel which has absorbed hydrogen behaves in a brittle manner, the elongation and number of bends required to produce failure being decreased markedly, although the tensile strength is practically unaffected.

(6) Steel which has been embrittled as a result of the absorption of hydrogen regains its ductility when the hydrogen is removed, but the recovery generally is incomplete. The permanent impairment in properties may be due to reaction of the hydrogen with some of the minor constituents in the steel.

(7) Only a low concentration of hydrogen in steel, much below that which may be produced by chemical reaction, is necessary to cause brittleness.

(8) Whether or not a specimen of steel will be embrittled by an aqueous solution may depend largely upon the degree to which the solution removes or prevents the formation of the protective coating of oxide on the metal surface.

(9) Direct inter-granular corrosion of steel by a boiler water or its concentrated saline may be possible but has never been definitely demonstrated.

(10) Selective corrosion of steel subjected to repeated or reversed stresses may lead to ultimate failure by fatigue.

Mechanical Properties of Low-Carbon Steel at Boiler Temperatures

No approach to the embrittlement problem from the viewpoint of chemical attack can afford to neglect the variation in properties of steel with change in temperature. In this connection it should be remembered that:

(1) The tensile strength of ordinary low-carbon steel is greater and the ductility is less at boiler temperatures than at room temperature.

(2) The increased tensile strength, decreased ductility, and step-shaped stress-strain curve of low-carbon steel at boiler temperatures are results of the same changes in steel responsible for aging after cold work.

(3) Any mechanical test of chemical attack upon steel should be considered with respect to the properties of the steel at the test temperature.

Cracking of Low-Carbon Steel Under Combined Chemical Attack and Mechanical Stress

From the large number of more or less contradictory details in the literature, certain important generalizations may be derived:

(1) The cracking of steel subject to chemical attack while under stress consistently commences in a region where the local stress is greater than the average.

(2) An unknown but probably very high local stress is necessary to initiate cracking.

(3) The yield point at room temperature is not a fundamental criterion of the stress necessary to cause cracking.

(4) The time required to break steel in tension while in contact with a concentrated solution of sodium hydroxide at an elevated temperature is not a direct measure of a rate of chemical attack.

(5) Most steels are subject to embrittlement, although there is some question concerning a possible greater resistance in the case of non-aging steel.

(6) When the steel is subjected to repeated stress in contact with sodium-hydroxide solutions at boiler temperatures, both hydrogen embrittlement and corrosion fatigue may play important parts in producing failure.

(7) It may be possible to prevent cracking of boiler metal, whether due to hydrogen embrittlement or corrosion fatigue, by the maintenance of protective coatings on the steel produced by the addition of specific chemicals to the boiler water.

Mechanism of Embrittlement Failure

A fundamental distinction must be made between two possible ways in which mechanical stress may produce failure in conjunction with chemical attack. On one hand, it is possible that mechanical stress accelerates a highly localized corrosion. On the other hand, it is equally possible that mechanical stress simply causes the ultimate cracking of steel previously made brittle by the absorption of hydrogen. In the first case, stress is essential in producing dangerous chemical attack; in the second, the chemical attack leading to a brittle condition is relatively independent of stress, except as the latter may tend to break a protective coating on the metal.

No very definite evidence has been found to support the theory of inter-granular corrosion, although the possibility of selective attack of this type as a special case of corrosion fatigue must be kept in mind. The experimental results used in support of the theory of inter-granular corrosion generally may be used also in support of the theory of hydrogen embrittlement.

A thoroughly logical picture of the way in which the failure of boiler steel may be caused by hydrogen embrittlement may be built up on the basis of the information discussed in this report. When a boiler goes into operation its internal surfaces immediately are covered with a layer of magnetic oxide. Under ordinary conditions this layer forms an almost impassable barrier between the boiler water and the steel. As the concentration of hydroxide increases, however, the layer becomes progressively less protective, and the reaction between the water and the steel increases its rate. This chemical reaction produces hydrogen, which diffuses into the steel and causes a definitely brittle condition, possibly by setting up internal stresses at grain boundaries and cleavage planes.

Although the steel may be rendered very brittle by the absorption of hydrogen, no serious permanent damage is done until a localized stress at some point reaches a very high value, probably well up toward the ultimate strength of the metal. A piece of normally ductile steel subjected to a high local stress of this sort would yield slightly, automatically reducing the local stress by distributing it over a large section of metal. The embrittled steel, however, instead of gliding along slip planes in the manner of ductile metal, ultimately will crack at the point of high local stress. Although the initial failure may be only the boundary between two grains in the outermost surface layer, it represents permanent damage to the steel. The high local stress, instead of being reduced in intensity, then may be transmitted to the next layer, with the result that the failure is eventually repeated here. As long as the concentration of hydrogen in the steel is sufficient to maintain it in a brittle condition, and as long as the local stress in the outermost sound layer of metal is sufficient to cause failure, the process of cracking will continue.

In applying this concept to actual conditions in a boiler, it should be remembered that the stresses in riveted seams are not simple tension stresses. Instead they are much more likely to include bending stresses in which a certain portion of the surface metal is subjected to a stress greatly above the average stress on the whole cross-section. Such a condition might assist in the process of chemical attack by damaging the protective oxide coating, in addition to its purely mechanical effect in causing failure of embrittled metal.

When water alone is in contact with steel, the oxide coating so greatly retards the rate of reaction that the hydrogen liberated is insufficient to produce any marked embrittlement at room temperature. It is, however, barely possible that at elevated temperatures in a boiler the rate at which hydrogen is evolved by an ordinary boiler water would be sufficient to produce a noticeable increase in brittleness of the boiler steel.

The theory that hydrogen embrittlement may be responsible for the failure of riveted seams and expanded tube ends, like all logical theories, may be proved incorrect by subsequent experimentation. Careful investigations of its validity by tests under boiler conditions is a matter of greatest importance if a rational basis for the prevention of embrittlement failures is desired.

Prevention of Embrittlement Failure

As has been noted, the oxide coating inevitably formed on the steel surfaces of a boiler in contact with water normally protects the metal from further reaction to produce hydrogen, except at a very slow rate. If, however, conditions allow the concentration of an alkaline boiler water in riveted seams, the protective effect of the oxide coating in these seams ultimately will be affected, with resultant acceleration of the rate at which hydrogen is liberated at the steel surfaces. An increase in sodium-chloride concentration presumably will have a similar effect.

Sodium sulphate in solution, even in small quantities, at first will tend to maintain the protective layer against the action of sodium hydroxide, but as the concentration of the latter builds up, particularly if sodium chloride is also present in appreciable amounts, the beneficial effect of the sulphate will disappear. The rate of attack of the saline solution on the metal in the riveted seam therefore will increase as the solution concentrates. The process of concentration furthermore will tend to be accelerated by the decomposition of water to liberate hydrogen. Unless some additional factor enters the situation, the rate of reaction between water and steel therefore will tend to increase indefinitely. If, however, some other protective layer, stable in contact with the saline solution, can be deposited upon the steel, the self-accelerating reaction between the steel and the solution may be retarded or even stopped.

The new protective layer might be produced on the steel by the chemical action of some hypothetical substance added to the boiler water, or it might result simply from the precipitation of a continuous, impervious deposit of some dissolved substance such as sodium sulphate or the less soluble constituents commonly found in boiler scales. It is perhaps pertinent to point out that embrittlement generally has occurred in boilers operating with boiler waters distinguished for their freedom from scale formation.

In any case, the prevention of embrittlement failures, in so far as it may be accomplished by control of water conditions, must depend fundamentally upon maintaining a stable, self-repairing coating upon the steel which effectively separates it from contact with the water.

An investigation of the behavior of the various coatings which might be produced by the addition of specific substances to the boiler water is probably the most important step which can be taken in the attempt to prevent embrittlement failures from the standpoint of boiler-water control. Because of the favorable indications from laboratory experiments and the increasing use of sodium phosphate as a water-conditioning chemical for other purposes, the possibility that this substance may assist in maintaining a stable protective coating demands particular attention.

Program of Research

In a study of various sodium salts the solubility relations in complex solutions have already been determined. The effect of solution composition upon cracking of boiler steel is an extension of this study with the following immediate objectives:

(1) To determine the lowest concentration of sodium hydroxide which is more effective than water alone in producing failure of boiler steel.

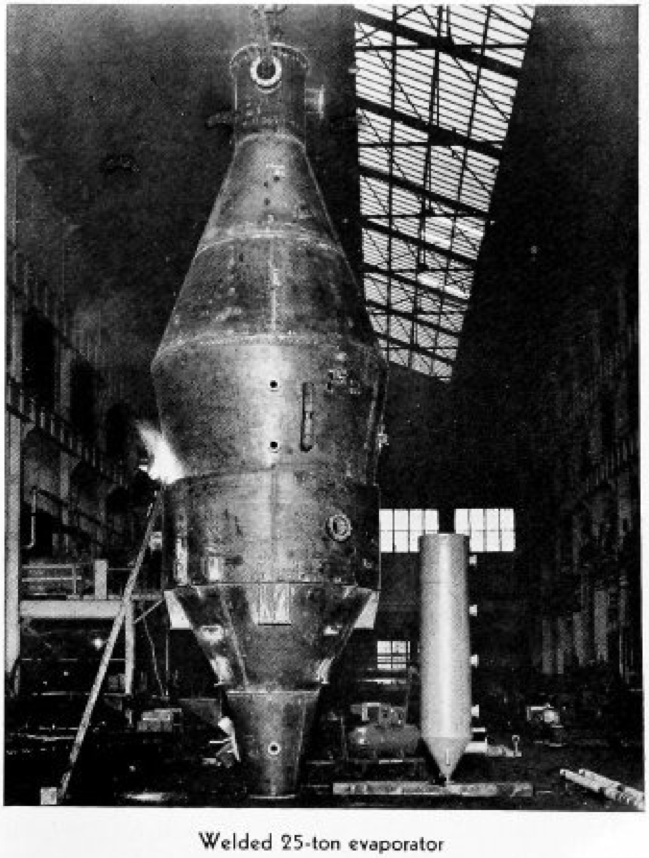
(2) To determine under what conditions sodium sulphate is effective in reducing or preventing the attack of boiler water salines upon steel.

Further extension of the work to include the effect of other substances present in boiler waters is contemplated. It is hoped that a rational basis for control of boiler water composition to prevent embrittlement failure may result from this investigation.

Large Evaporator Is Arc Welded

To provide salt for America's breakfast table, this 25-ton evaporator was designed and completed for one of the largest salt manufacturers. In it wet salt is stirred up by a bronze propeller, circulated through 828 copper tubes, distilling off the water.

This giant salt maker, designed by Clinton S. Robinson & Associates, Chicago, is about 50 feet long, 12 feet in diameter at its widest point. It was built by



Welded 25-ton evaporator

the Wellman Engineering Company, Cleveland, entirely by shielded-arc welding. Arc welded steel, replacing cast iron, saves approximately 50 percent of the weight, materially reduces the cost, and builds a stronger job. Proof of strength: A crane yanked the evaporator by the neck from prone position, stood it on end.

British Engineers Study High-Pressure Marine Boilers

By G. P. Blackall

Seven boilers were surveyed in the recent symposium on high-pressure marine boilers at the Institute of Marine Engineers, London, and, from the detailed analysis offered of each and the subsequent discussion, it is evident that a definite impetus has been given to the consideration among marine engineers of the high-pressure boiler in its newest developments.

In the more revolutionary designs the cardinal feature is the abolition of the high-pressure steam drum. Of these "flash-type" boilers, in which water enters at one end of a tube to emerge as steam at the other, the Benson and the Sulzer Monotube are leading examples. The former has been successfully installed in the steamer *Uckermark*, of the Hamburg-Amerika Line, and it is to be employed in the new turbo-electric vessel *Potsdam*, now under construction at Hamburg for the same line.

Although this generator was originally designed to work at the critical pressure of steam—3250 pounds per square inch—it is equally adaptable to a lower pressure, as in the *Uckermark*, and in the *Potsdam* about 1500 pounds will probably be adopted.

So far operating results with the Sulzer Monotube boiler in ships are not available, but it has been very successfully tested on land, and the first marine installation is to be made in the Rotterdam Lloyd freighter *Kertosono*. In this ship of 16,500 tons, double-reduction geared turbine machinery driving a single screw was originally fitted, steam being supplied by five Scotch boilers at a working pressure of 205 pounds per square inch. The new high-pressure ahead turbine which is to be fitted is to work in conjunction with the existing slow-speed gear wheel through a double-reduction gear designed to prevent overloading of the existing pinions. One of the Scotch boilers will be removed to make room for a Monotube unit which will generate steam at 880 pounds pressure at 705 degrees F. temperature, and only one of the remaining four will normally be in operation, to supply steam for the auxiliary machinery. The maximum continuous output of the new steam generator will be about 21 tons of steam per hour with oil-firing, and with the output of the machinery increased from 4500 shaft horsepower to 5800 shaft horsepower, it is confidently anticipated that the vessel's speed will be increased from 13 knots to 15 knots.

The Velox boiler probably constitutes the greatest departure from the conventional idea of a steam generator, but it is capable of a very high steam output and is believed to have considerable potentialities for both naval and mercantile vessels. A Velox boiler has been ordered by the British Admiralty for trial, and on the results of its trial will depend how far the British Navy is willing to adopt this new development.

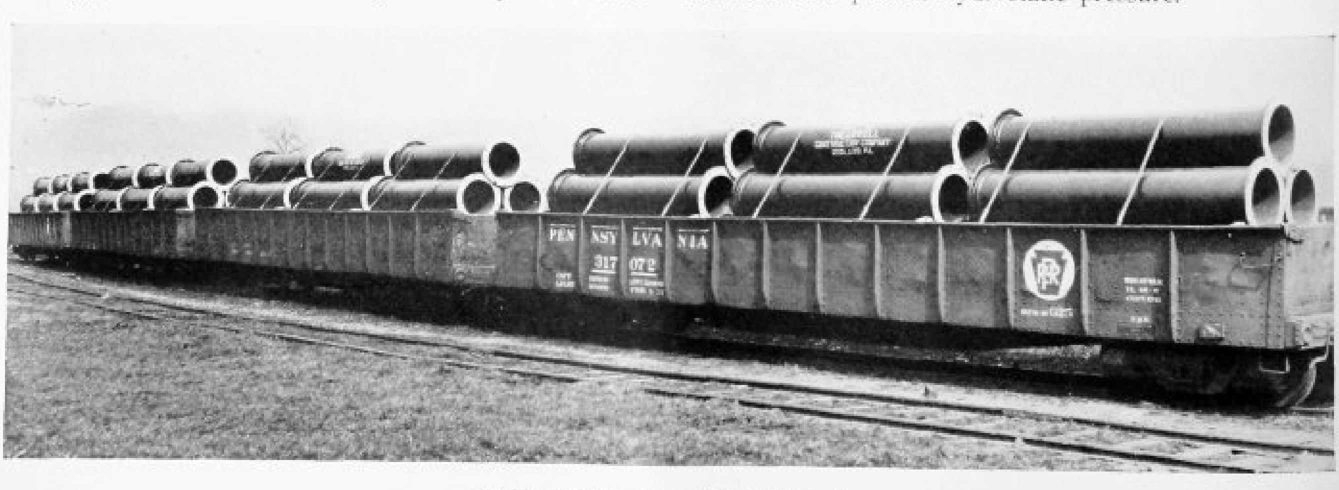
The Loeffler boiler, which is now fairly well known, was also dealt with in the symposium. In this type all the steam is generated in vessels not exposed to external heat, while the tubes which are heated externally contain only clean, dry, and dense steam. Steam at a pressure of 1900 pounds per square inch has a specific volume so low that it can economically be circulated by a pump, and the velocity at which it is passed through the tubes ensures a small loss of temperature between the steam and the metal walls of the tubes. This velocity is approximately 65 feet per second for maximum capacity, and under these conditions it is claimed that 40,000 British thermal units can be transmitted per square foot of radiant superheater surface per hour without risk of overheating the metal.

The other boilers represented at this symposium were the Atmos, in which the fuel is burned within a cage rotor; the Wagner-Bauer and the La Mont. Experience with the two latter types in liners has already become available. More still requires to be learned about the performance of the other five.

Arc Welded Dredge Pipe

The four carloads of welded dredge pipe, shown in the illustration, were recently completed by the Treadwell Construction Company, Midland, Pa., for the United States Engineers at Fort Peck, Mont. This pipe, which has a section 28 inches in diameter, is fabricated of ¾-inch rolled steel plate, prepared with a double vee groove for welding.

All the longitudinal seams were welded with Champion Red Devil electrodes. After welding, the pipe was tested to 500 pounds hydrostatic pressure.



Carloads of Champion welded dredge pipe

PRACTICAL PLATE DEVELOPMENT—IV

Tapered Connection Piece

By George M. Davies

The tapered connection piece between pipes of unequal diameters, to be developed is illustrated in Fig. 40. This illustrates two parallel pipes 48 inches and 36 inches in diameter, spaced 72 inches between centers. The tapered connection is 36 inches in diameter at the large end, 24 inches in diameter at the small end, the connection tapering from the large pipe to the smaller pipe.

To develop the pattern of the connection piece, lay out the elevation, Fig. 41, to the dimensions given in Fig. 40, the pipes being laid out using their outside diameters, and the connection piece using the neutral diameters, at the large and small ends.

Extend the lines *P-S* and *Q-K*, until they intersect at *O*. Extend *O-Q* cutting the center line of the large pipe at *F*, and extend *O-P* cutting the center line of the large pipe at *E*.

Bisect *E-F*, locating *R*. Connect the points *R* and *O*. The line *R-O* divides the connection piece into two symmetrical halves and therefore the pattern of one half can be duplicated for the other half; thus requiring the development of one-half of the connection piece only.

With *R* as a center and with a radius equal to *R-F*, scribe a semicircle, as profile, Fig. 43. Divide the semicircle *E-F* into any number of equal parts, eight being taken in this case. Number these points from *1* to *9*, as shown.

Then parallel to *O-R* draw lines through the points *1* to *9*, cutting the line *E-F*, locating the points *1* to *9* on *E-F*. Connect the points *1* to *9* on *E-F* with *O*.

Next, construct the end view, Fig. 42, as follows: At *T*, any point on *A-B*, erect *M-N* perpendicular to *A-B*; next erect a perpendicular to the center line *O-R* at *O*, extending same cutting the line *M-N* at *O'*.

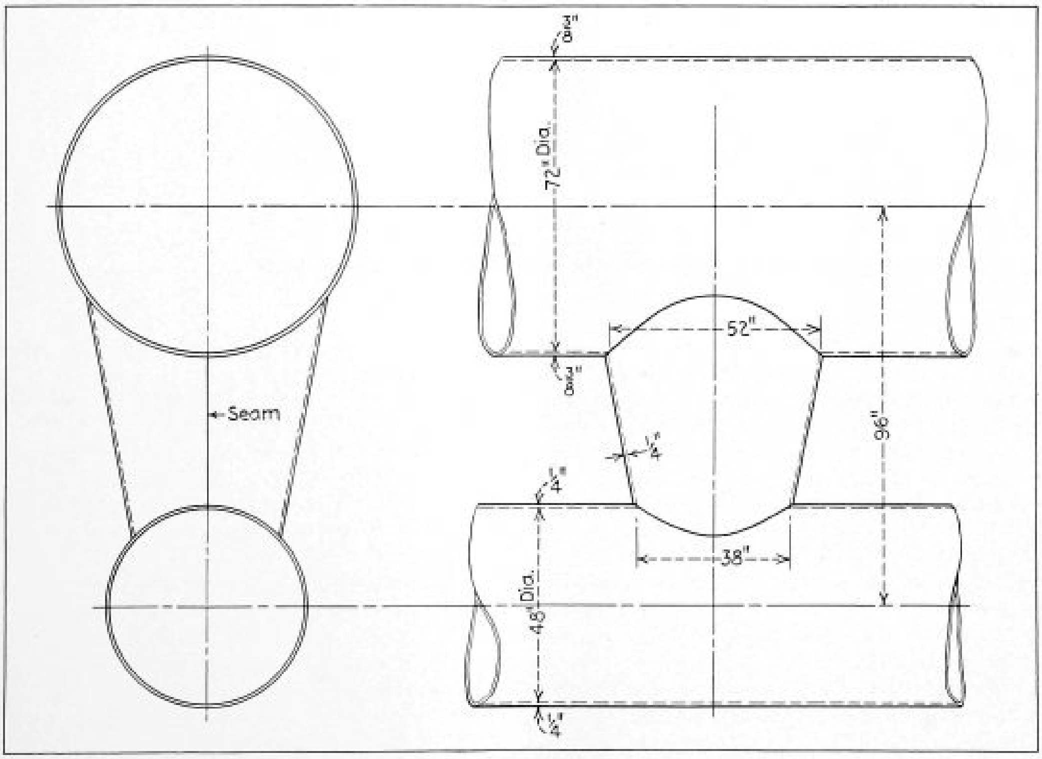
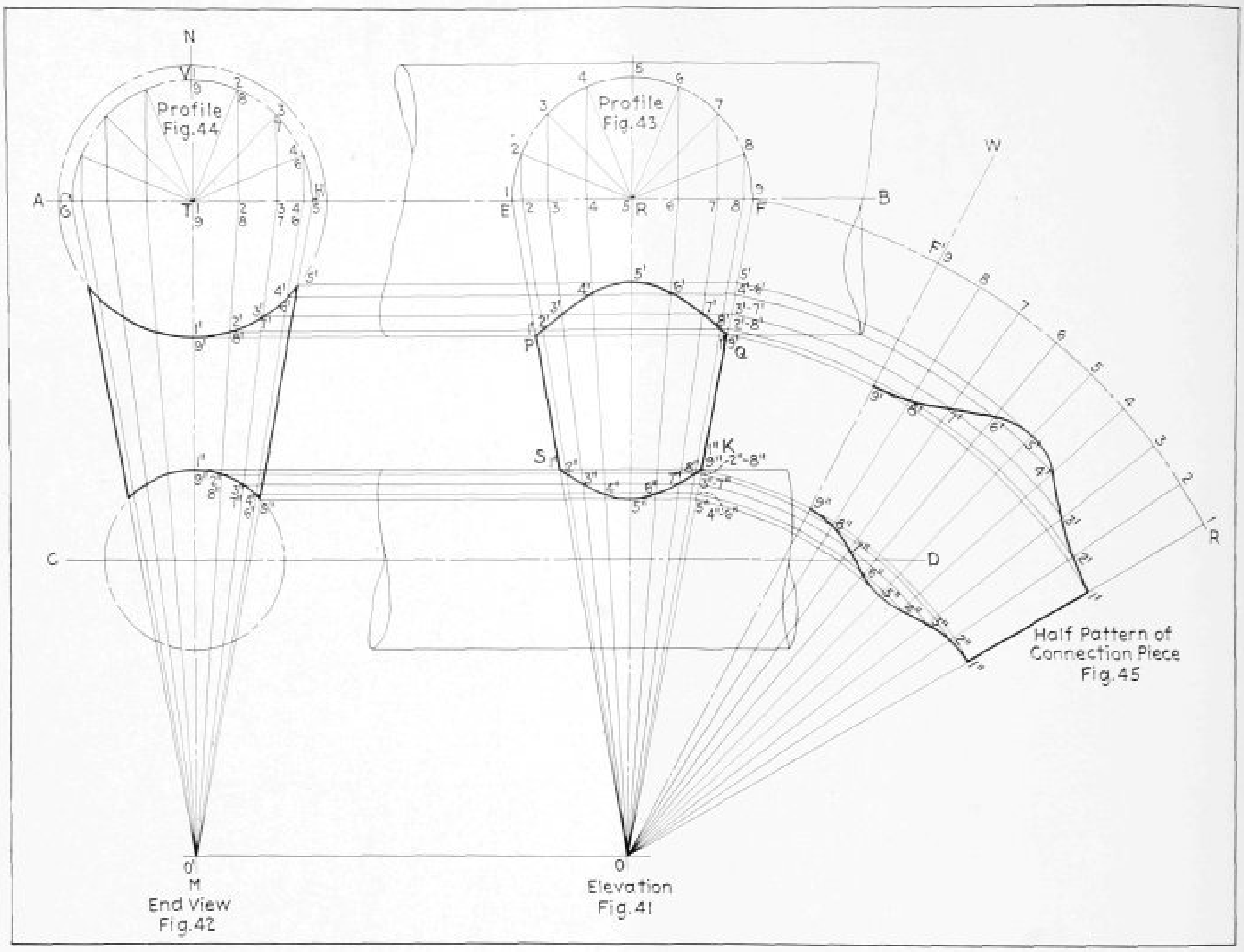


Fig. 40.—Connection between pipes of unequal diameters



Figs. 41 to 45.—Development of tapered connection piece

Then with *T* as a center and with a radius equal to *R-F*, Fig. 43, scribe the semicircle *G-H*, Fig. 44, and divide it into the same number of equal parts as taken in profile Fig. 43. Draw lines through these points parallel to *M-N*, cutting the line *A-B* from *G* to *H*, and connect these points with the center *O'*, completing the end view as shown.

To Obtain the Miter Lines

To obtain the miter lines in the elevation, number the points on the arc *V-H* in profile, Fig. 44, and along the line *T-H*, from *1* to *9* to correspond with the points *1* to *9* in Fig. 43, as shown.

Where the lines drawn from these points to the center *O'* cut the circumferences of the parallel pipes, number these points from *1'* to *9'* and from *1"* to *9"*, as shown.

Then parallel to *A-B* draw a line through the point *5'* of the end view, Fig. 42, cutting the line *O-R* of the elevation, locating the point *5'*. Then parallel to *A-B* draw a line through the point *4'* and *6'* of the end view, Fig. 42, cutting the lines drawn from the points *4* and *6* to the center *O* in the elevation, Fig. 41, locating the points *4'* and *6'*, Fig. 41. Continue in this manner until the points *3'*, *7'*, *2'*, *8'*, *1'* and *9'* are located. Connect the points *1'* to *9'*, Fig. 41, which line will be the miter line between the connecting piece and the large diameter pipe.

In the same manner locate the points *1"* to *9"*, Fig. 41, constructing the miter line between the connecting piece and the small diameter pipe.

To Construct the Pattern

Parallel to *A-B* draw lines through the points *1'* to *9'*, Fig. 41, cutting the line *O-F* at points *1'* to *9'* as shown. Then parallel to *C-D* draw lines through the points *1"* to *9"*, Fig. 41, cutting the line *O-F* at points *1"* to *9"*, as shown.

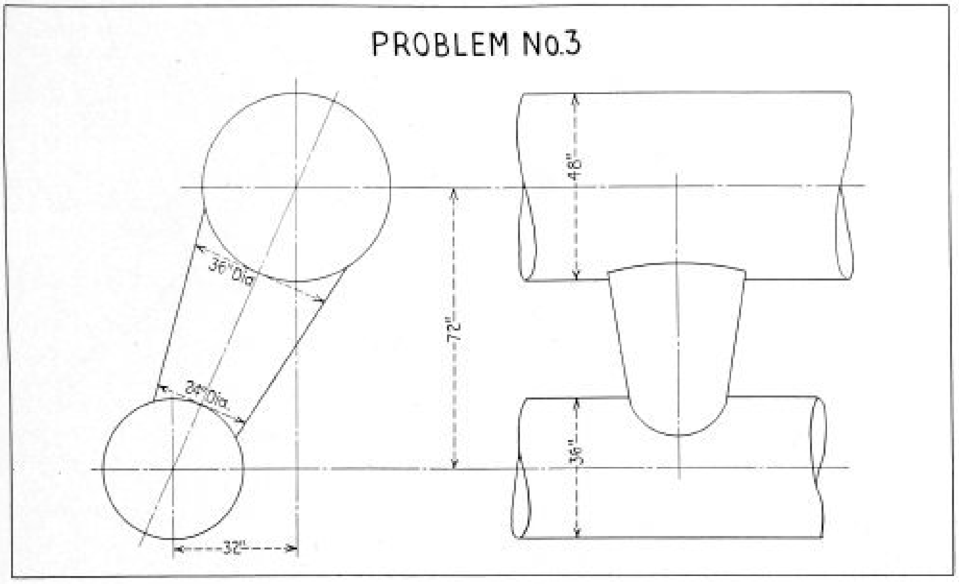
Next draw the line *O-W*, Fig. 45, and with *O* as a center and with *O-F*, Fig. 41, as a radius, scribe an arc cutting *O-W* at *F'*. From *F'* on the arc just drawn step off eight equal spaces, the spaces being taken equal to the spaces in the profile, Fig. 43. Number the points from 9 to 1 as shown. Connect the points *1* to *9*, Fig. 45, with the center *O*.

Then with *O* as a center and with a radius equal to *O-9'*, taken on the line *O-F*, scribe an arc cutting the line *0-9* of Fig. 45, locating the point *9'*, Fig. 45. Then with *O* as a center and with a radius equal to *0-2'* and *0-8'* taken on the line *O-F*, scribe an arc cutting the lines *0-8* and *0-2*, Fig. 45, locating the points *8'* and *2'*, Fig. 45.

Continue in this manner until the points *3'*, *7'*, *4'*, *6'* and *5'* and the points *1"*, *2"*, *3"*, *4"*, *5"*, *6"*, *7"*, *8"*, *9"* have been located. Connect these points with curved lines completing the half pattern of the connecting piece as shown in Fig. 45.

(To be continued)

Problem No. 3—For Readers to Lay Out



Practice Problem No. 3, is designed to give experience in applying the principle of development embodied in the "Tapered Connection Piece" (between pipes of unequal diameters) as explained in this instalment of "Practical Plate Development," beginning on page 157. The correct solution will be published in the August issue, at which time those who have made the development and wish to check their work may do so. Any questions arising in connection with this development or your method of solving the problem may be addressed to the author in the care of this office

Why Carry the Burden of Obsolete Facilities?

During the past five years the railroads of this country have, through force of necessity, been operating under a policy involving severe retrenchment in the purchase of equipment which contributes to the improvement of property. During that time the industries which manufacture equipment used on railroads have devoted much of their time to the development of new ideas which are now available and ready to help effect the economies the railroads must make to assure profitable operation. The fact that the roads have been reluctant to make expenditures for property improvement has given rise to the feeling in some quarters that railroad management is not progressive and that it has no desire to take advantage of modern improvements in order to cut costs. Those who are in close contact with railroad problems and know by experience that there are many obstacles which tend to restrict that freedom of action so common in some other industries do not share that feeling.

Of all the problems in railroading there is none of greater magnitude, when viewed from the standpoint of operating expenditures, than that involved in the maintenance of equipment. Twenty-seven percent of the money spent for operation is spent for this purpose and in normal times this represents an average of approximately 400 million dollars a year. The facilities used for the maintenance of equipment represent an investment of one billion dollars of which 320 million is in shop machinery, a large part of which investment is admittedly obsolete both from the standpoint of age and of productive capacity.

In any consideration of a question of such magnitude and importance as that of equipment maintenance, it is worth while to keep clearly in mind the fact that, as rail traffic increases, the unit costs of equipment repairs will probably increase disproportionately unless management takes steps to control that tendency by taking advantage of modern methods and equipment to effect economies. The question naturally arises as to the direction in which efforts should be directed to bring this about. It is fortunate that, during the past five years, a great deal of thought and careful study has been given to the question and that we are much better equipped to provide an answer than we were five years ago. Studies made by various agencies indicate that substantial economies may be effected in equipment maintenance by the introduction of modern motive power to replace obsolete power, which can be operated under any condition only at greater cost than is justified, and in the replacement of obsolete and inadequate shop facilities. These are two phases of the problem which must be considered jointly for to introduce modern motive power without also making the necessary improvements to repair facilities would only result in preventing the roads from enjoying all of the savings they have a right to expect. On the other hand the importance of improving shop facilities can best be appreciated when it is considered that such improvements begin to return savings on the investment immediately they are installed and, as new motive power is introduced, it can be done with the confidence that a threefold objective has been reached—reduced repair costs as a result of modern design; reduced costs of operation on the road and the lowest possible repair costs when the locomotive comes to the engine house and the back shop.

That shops and engine houses have not been given the consideration by management they seem to deserve is indicated by the fact that less than four percent of all the money spent for additions and betterments on the Class I roads over a period of 17.5 years prior to 1932 was spent for improving the facilities which the industry uses to maintain equipment the cost of which maintenance represented 27 percent of all operating expenses.

A review of the foregoing facts seems to point quite clearly to the need of a definite policy in relation to motive power and equipment—one which will assure the systematic replacement of obsolete locomotives and cars and obsolete repair facilities over a period of years in order ultimately to arrive at a point where the average age of equipment is materially reduced and where reduced maintenance costs may be enjoyed as a result of improvements in equipment, repair facilities and methods. The establishment of such a policy can best be brought about by an intensive study of the mechanical and operating problems of individual roads.

Can New Shop Tools Be Justified?

There are those who are of the opinion that one of the reasons why machine tools in the railroad field have been continued in service, in many cases far beyond the end of their economic life, is that the long-established policies in relation to depreciation have not been sound and that had the roads, like some other industries, set up adequate depreciation there would have been a reserve out of which to purchase new tools. Three facts in this connection are important: (1) Accounting practices employed by the railroads are not of their own choice but are established by the Interstate Commerce Commission; (2) The I. C. C. has already ordered the roads to change over from retirement to depreciation accounting and (3) regardless of accounting methods, should a cash reserve be set up, that portion of the reserve fund established as a result of shop machinery depreciation would not, in all likelihood, be earmarked for machinery purchases but would be thrown into a fund which would be spent for those improvements which would return the greatest saving on the investment. If this be true it is evident that the only justification for the purchase of new machine tools is that by their increased productive capacity and lower machine maintenance costs they will return as great or a greater percentage on the investment than any other equipment that could be purchased.

Studies which have been made in this and other industries leave no doubt that modern machines, as compared with those 20, 30 or even 40 years old, can not only effect substantial economies but can in many instances pay for themselves in a relatively short period of time. It would be worth while for mechanical officers to investigate the potentialities of profiting by installing improved machine equipment through greater producing capacity or, at least consider that such installations would cut down the operating losses by reducing machine-tool operating and repair costs. Such a reduction can best be brought about by an intensive study of the conditions surrounding his operation and where it is discovered that obsolete facilities stand in the way of improvement a policy of equipment replacement can be adopted with the confidence that improvements in equipment—whether it be locomotives or repair facilities—will assure a satisfactory return on the investment.—*Railway Mechanical Engineer.*

Improved Circulation for Watertube Boilers

By G. P. Blackall

It is well known that watertube boilers should, to ensure efficiency, have the tubes disposed so that they are in longitudinal contact with adjacent tubes from one header to the other. A construction has been adopted in a new invention of H. A. Richard, an English engineer, in which a number of tubes of small diameter are employed, each in contact with the tube on either side, and held at the ends by a block member cast or welded around the tubes.

Intense heat enables a water vapor emulsion to be produced, so that an improved water circulation is obtained. Mr. Richard also claims a number of advantages for the use of the construction in gas-fired boilers which may be used for central heating purposes.

Manual for Foremen

The importance of supervisory forces in the present-day industrial organization emphasizes the need for the adequate and simplified plan for the training of foremen and other supervisors, contained in the manual "Foremanship Development." The manual is based upon the experience of the Westinghouse Electric and allied companies, and that of others who have been active in supervisory training. It is intended for both group leaders and the members of conference groups.

The first part briefly presents the increasingly important place which the foreman and the supervisor hold in industrial organization. Then follows a series of practical suggestions for conference leaders, including underlying fundamentals, suggested methods, conference technique, self evaluation for leaders, a working library, etc. The final section outlines a series of 38 conferences on major problems in foremanship, including outlines for discussion on collective bargaining, foremen as managers, as leaders, labor turnover, waste, developing understudies, company policies, wages, co-operation, self analysis, and similar topics.

The course is especially suited to industrial organizations and especially to those which are not in a position to develop a foremanshp training course of their own and yet feel the need of carrying on such a program. Another field of usefulness is in connection with college courses in industrial management. The manual is an excellent introduction to this subject, used either as course material or for seminar outline work. The price of this manual is one dollar, and it may be obtained from the Industrial Relations Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

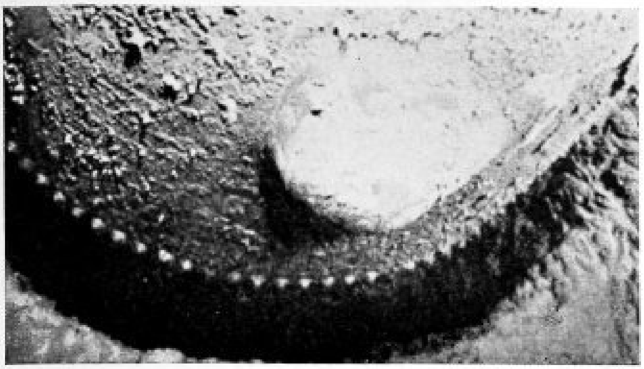


Fig. 1.—An example of extreme bulge because of scale

Repairing Bulged

SHELL PLATES AND DRUMS

By J. P. Morrison*

While bulges in boiler plate are usually serious weaknesses, it is often possible to make repairs which will permit the continued safe use of the vessel. In order to design such repairs, however, it is necessary to know accurately what caused the bulge and to determine definitely whether the plate is weakened over more than a small area. The cause and extent of the defect, therefore, are important, because there are certain conditions which make the scrapping of the affected plate the only safe remedy.

It is a fundamental fact that bulged or distorted boiler plates are the result of stresses greater than the metal could withstand without a change in shape. The overstressed condition may have been attributable to one of three causes:

1. Decrease in the yield point of the steel as the result of high temperature.
2. Decrease in the thickness of the plate.
3. Defective material.

The kind of bulge most frequently encountered occurs in a shell plate or drum surface which is exposed to furnace temperatures. Such a bulge is the result of overheating because of low water or the presence of scale or oil.

Oil used for the internal lubrication of steam engines or steam pumps is a poor conductor of heat. This oil reaches the boiler in condensate from the engine's exhaust steam, unless adequate steps are taken to remove it before the condensate is returned to the boiler. An exceedingly thin coating of such oil inside the lower plate surfaces of the boiler will prevent intimate contact of the water with the metal, thereby retarding the passage of the heat through the shell plate to such an extent that the plate will reach a temperature where deformation will occur under normal working pressure.

A bulge in the fire sheet of a horizontal tubular boiler, if caused by overheating because of oil, is frequently of considerable area but may be more or less shallow. The distorted area may extend longitudinally from girth seam to head seam and girthwise through an arc of 90 degrees or more. If the depth of the bulge does not exceed the thickness of the plate and the oil can be entirely eliminated, no repairs, save perhaps calking of the seams, are necessary since the reduction in the thickness of the plate has been negligible. Any effort to "set up" or to "drive back" a bulge of great area is likely to produce a number of comparatively small pockets in which sediment can accumulate—a condition which is considered more dangerous than the slightly distorted plate. If the depth of the bulge indicates a dangerous reduction in the thickness of the plate, a new fire sheet may be necessary.

When a new fire sheet is installed, the longitudinal seams must be located well above the fire line. It is good practice to attach the new sheet on one side at the original longitudinal seam of the course. On the other side the new seam should be located so that it will "break joint" with the longitudinal seam of the adjoining course, that is, the two seams should not be at the same point

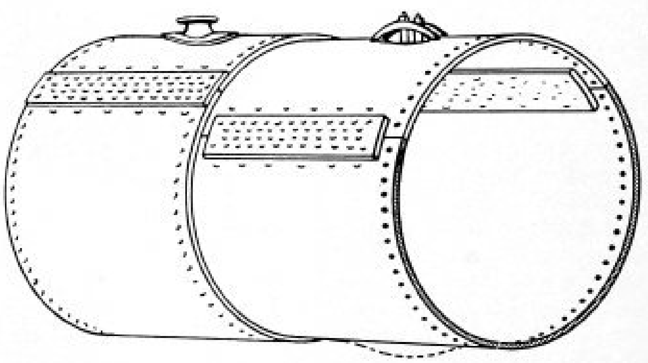


Fig. 2.—Oil deposit caused this bulge

on the circumference of the boiler, Fig. 2. The cost of a repair of this kind, when made with the boiler in place, may exceed the cost of putting on a complete new course at a well equipped boiler shop. The expense of removing the boiler from its setting, shipping it to and from the boiler shop, the repair work (which is likely to include a number of new tubes), and the re-installation of the boiler will probably equal, if not exceed, the cost of a new bare boiler. All these factors, in addition to the question of safety, must be taken into consideration when deciding upon what repairs to make and how to make them.

The repair of bulged metal weakened by overheating because of the accumulation of scale is often of a less extensive nature than that described above. A coating of scale on the fire sheet of a boiler may be of considerable thickness without causing dangerous overheating of the plate. As scale increases in thickness, a point is reached at which it ceases to be merely a cause of added

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fuel expense and becomes a hazard as well. What this dangerous thickness is depends on the nature of the scale. Sometimes scale in dangerous amounts does not adhere persistently to the plate, but breaks off in flakes and accumulates in a loose form. Indeed, it may not deposit as scale at all, but may remain as suspended matter that accumulates as a sludge which gradually settles on the heating surfaces. In either the solid or the loose form, this foreign substance within the boiler may

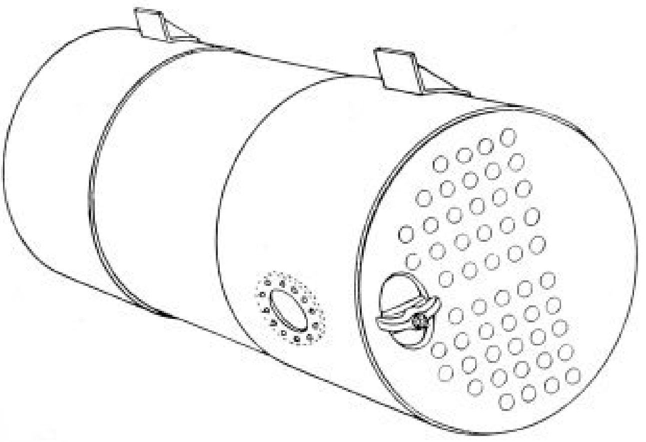


Fig. 3.—Repair of bulge caused by overheating

retard the heat transfer to such an extent that overheating occurs. Then the pressure tends to force the plate out of shape. Such a change frequently causes the scale to break off or to shift its position, thus permitting the water to reduce the temperature of the plate to normal. In such cases, the bulge is not of great depth, and the material has not been seriously damaged. Consequently, a crew of skilled workmen can heat the distorted part and restore the sheet to practically its original contour.

If the accumulation of scale is not dislodged when the shell plate bulges slightly, the overheating and bulging may continue until the plate ruptures and leakage developes at the apex of the bulge. Bags or bulges resembling the crown of a derby hat are not uncommon where poor feed water is used and where the boilers are not cleaned as thoroughly or as frequently as they should be. A bulge, because of overheating due to scale, is shown in one of the illustrations.

If the depth of such a bulge is not more than 25 percent of its diameter, it may be possible to restore the plate practically to its original shape by proper heating and hammering. Even if there is no rupture at the apex of the bulge it is well to drill a hole of about 1 inch diameter at that point in order to determine the thickness of the plate and to facilitate the upsetting of the bulged metal. A welding torch, secured to a long handle, may be used to heat the plate on the inside surface while the outside surface is hammered. A cast iron form of proper shape can be used to advantage inside the boiler as a face plate. After the bulge is "set up," the hole that was drilled in its apex should be reamed and closed with a rivet.

Patching should be a last resort, although it cannot be avoided if the bulged material has been "burned," if a considerable area of the plate has been seriously reduced in thickness, or if the bulge has a rupture too large to be closed with a rivet.

Since a patch should be no larger than is absolutely necessary, it is better and cheaper to heat the bulged portion of the plate and straighten it as much as possible before cutting out whatever area must be removed. Assuming that the bulge is near the center of one of the courses of the shell plate, the patch may be practically round or somewhat oval, depending upon the shape of the bulge and the extent of the thinned material, see Fig. 3. The patch must be of such size that it will pass through the manhole, or, if larger, it must be of such shape that it will pass through the opening it is to close. The patch should be secured to the inside surface of the shell plate, unless the blow-off pipe is to be connected.

The strength of a patch seam is frequently questioned. Theoretically, a circumferential seam will withstand twice the boiler pressure of a longitudinal seam of similar design. A seam in a diagonal or circular position will withstand a greater pressure than a longitudinal seam, but less pressure than a circumferential seam. To obtain adequate strength, patches are usually of crescent or horseshoe shape with the dimension lengthwise of the boiler not more than half of the dimension crosswise of the boiler.

When the normal working pressure causes a bulge to form in a plate that has been reduced in thickness and in strength by internal or external corrosion, the distortion of the plate is likely to be followed by a rupture extending across the entire corroded area. This may result in a serious, if not an extremely violent, accident.

If the condition is found before a serious rupture occurs and the value of the boiler justifies it, repair by patching is permissible, provided the other parts of the boiler are not damaged or weakened. Regardless of whether the boiler is repaired or replaced by a new one, it should not be operated under conditions that will permit corrosion again to develop undetected.

A bulge in the shell of a steam boiler constructed of modern material is seldom due to an initial defect in the plate. However, the steel-making processes in use some years ago resulted frequently in such defects as laminations, which were due to gas pockets in the ingot. These weaknesses are difficult to detect until overheating causes a blister to form.

If the gas pocket was small, the lamination and any resultant blister or bulging of the outer part of the shell plate, due to overheating, is also comparatively small and may be properly repaired by cutting off the outer surface of the plate with a chisel. Usually such a blister is near the middle of the plate thickness and it is generally circular or oval in shape. As the greatest dimension seldom exceeds 10 inches, a defect of this kind may be considered as satisfactorily repaired when the bulge is removed.

World's Largest Forging Press

A new heavy forge has just been completed at the Vickers works of the English Steel Corporation, Sheffield, and constitutes an important addition to the technical resources of the great British steel center. This development has been undertaken because of the greatly increased demand for boiler drums and hollow-forged vessels.

The forge is capable of handling ingots up to a weight of 280 tons. It will receive its cast material from the Siemens melting department recently completed at the Vickers works. The chief feature of the new forge is an 8800-ton forging press, claimed to be the largest in the world, operated by a high-pressure electro-hydraulic pumping set. It has a penetration speed of 2 inches per second and will give ten 5-inch penetration strokes per minute at full load.

Revisions and Addenda to the A.S.M.E. Boiler Code

It is the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the Rules and its Codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later in the proper place in the Code.

The following proposed revisions have been approved for publication as proposed addenda to the Code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the Code, and are submitted for criticism and approval from any one interested therein. It is to be noted that a proposed revision of the Code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

SPECIFICATIONS S-24 TO MAKE THESE SPECIFICATIONS IDENTICAL WITH A.S.T.M. SPECIFICATIONS B 43-33. Revise as follows:

PAR. *3b*. Second sentence. Revised:

Semi-annealed pipe, which is suitable for ordinary purposes, shall be furnished EXCEPT THAT RED BRASS PIPE MAY BE FURNISHED HARD DRAWN [unless otherwise specified].

PAR. 4. Add the following chemical compositions:

	ADMIRALTY METAL (NOTE)	RED BRASS
Copper, per cent	70.00-73.00	84.00-87.00
Lead, max, per cent	0.07	0.07
Iron, max, per cent	0.07	0.07
Tin, per cent	0.90-1.20	0.15 maximum
Zinc, per cent	remainder	remainder

NOTE: THE IDEAL COMPOSITION FOR ADMIRALTY METAL IS 70 PER CENT OF COPPER, 29 PER CENT OF ZINC, AND 1 PER CENT OF TIN, AND BETTER TUBES WILL BE OBTAINED BY ADHERING AS CLOSELY AS POSSIBLE TO THIS COMPOSITION, PARTICULARLY AS TO TIN. IT DOES NOT, THEREFORE, SEEM WISE TO MAKE 1 PER CENT OF TIN THE MINIMUM BUT RATHER, IN ORDER TO OBTAIN AS NEARLY 1 PER CENT AS POSSIBLE, TO ALLOW SOME VARIATION UNDER 1 PER CENT AND MAKE THE MINIMUM LIMIT FOR TIN 0.90 PER CENT. OWING TO THE FACT THAT A MINIMUM OF 1 PER CENT TIN HAS HERETOFORE EXISTED, CASES WILL OCCUR, UNTIL THE PRESENT SPECIFICATIONS BECOME UNIVERSAL, WHERE THE TIN MAY EXCEED THE 1.20 PER CENT MAXIMUM. IT IS NOT CONSIDERED THAT THIS WOULD BE HARMFUL OR SHOULD BE MADE A CAUSE FOR REJECTION.

PAR. 6. Add the following as (*b*):

(*b*) SPECIMENS OF HARD-DRAWN RED-BRASS PIPE SHALL BE ANNEALED PREVIOUS TO THE HAMMERING TEST.

PAR. 7. Add the following as (*b*):

(*b*) SPECIMENS OF HARD-DRAWN RED-BRASS PIPE SHALL BE ANNEALED PREVIOUS TO THE FLATTENING TEST.

SPECIFICATIONS S-29. A.S.T.M. Specifications for Seamless 70-30 Brass Condenser Tubes and Ferrule Stock (B 55-33) will be incorporated in the Code as Specifications S-29.

SPECIFICATIONS S-30. A.S.T.M. Specifications for Seamless Muntz Metal Condenser Tubes and Ferrule Stock (B 56-33) will be incorporated in the Code as Specifications S-30.

SPECIFICATIONS S-31. A. S. T. M. Specifications for Seamless Admiralty Condenser Tubes and Ferrule Stock (B 44-33) will be incorporated in the Code as Specifications S-31.

PARS H-63 and H-116. Revised:

H-63 (H-116) *Water-Column Pipes.* The minimum size OF FERROUS OR NON-FERROUS pipes connecting the water column of a steam boiler shall be 1 in. (The following sentence to appear in Par. H-63 only:) The steam connection to the water column of a horizontal-return tubular boiler shall be taken from the top of the shell or the upper part of the head; the water connection shall be taken from a point not less than 6 in. below the center line of the shell. No connections, except for [combustion] regulator, or drain, or steam gage, shall be attached to A [the] water column or the piping connecting a water column to a boiler (SEE PARS. H-38 AND/OR H-91 FOR INTRODUCTION OF FEEDWATER INTO BOILER). If the water column or gage glass is connected to the boiler by pipe and fittings, a cross tee, or equivalent, in which a drain valve and piping may be attached, shall be placed in the water piping connection at every right-angle turn to facilitate cleaning. Water-glass fittings and/or gage cocks may be ATTACHED [connected] direct to a boiler.

PARS. H-64*a* and H-117*a*. Revised:

H-64 (H-117) AUTOMATIC *Low-Water Fuel Cut-Off* AND/OR WATER-FEEDING DEVICE. *a* It is recommended that ALL [each] automatically fired steam OR [and] vapor-SYSTEM [heating] boilers be EQUIPPED [provided] with AN AUTOMATIC low-water fuel cut-off AND/OR WATER-FEEDING DEVICE SO CONSTRUCTED THAT THE WATER INLET VALVE CANNOT FEED WATER INTO THE BOILER THROUGH THE FLOAT CHAMBER, AND SO LOCATED AS TO AUTOMATICALLY CUT OFF THE FUEL SUPPLY AND/OR SUPPLY REQUISITE FEED WATER WHEN THE SURFACE OF THE WATER FALLS TO THE LOWEST SAFE WATER LINE [of dependable construction].

SUCH A FUEL OR FEED WATER CONTROL DEVICE MAY BE ATTACHED DIRECT TO A BOILER OR TO THE TAPPED OPENINGS PROVIDED FOR ATTACHING A WATER GLASS DIRECT TO A BOILER, PROVIDED THAT SUCH CONNECTIONS FROM THE BOILER ARE NON-FERROUS TEES OR Y'S NOT LESS THAN ½ IN. PIPE SIZE BETWEEN THE BOILER AND THE WATER GLASS SO THAT THE WATER GLASS IS ATTACHED DIRECT AND AS CLOSE AS POSSIBLE TO THE BOILER; THE STRAIGHT-WAY TAPPING OF THE Y OR TEE TO TAKE THE WATER-GLASS FITTINGS, THE SIDE OUTLET OF THE Y OR

TEE TO TAKE THE FUEL CUT-OFF OR WATER-FEEDING DEVICE. THE ENDS OF ALL NIPPLES SHALL BE REAMED TO FULL-SIZE DIAMETER.

PARS. P-104 and U-72*a*. Insert the following as the first two sentences:

"The plates may be cut to size and shape by machining or shearing, or by flame cutting if the carbon content does not exceed 0.35 per cent. If shaped by flame cutting, the edges must be uniform and smooth and must be freed of all loose scale and slag accumulations before welding. The discoloration which may remain on the flame-cut surface is not considered to be detrimental oxidation."

PAR. P-198*a*. Revise definitions to read:

"$C = 0.25$ for heads forged integral with or butt welded to shells or pipes as shown in Fig. P-14½*d* and *e*, where the corner radius on the inside is not less than 3 times the thickness of the flange immediately adjacent thereto, AND WHERE THE WELDING MEETS ALL THE REQUIREMENTS FOR CIRCUMFERENTIAL JOINTS GIVEN IN PARS. P-101 TO P-111, INCLUDING STRESS RELIEVING AND RADIOGRAPH EXAMINATION,"

"$C = 0.30$ for flanged plates attached to shells or [nozzle-necks] PIPES as shown in Fig. P-14½*c* by means of lap-RIVETED joints, where the corner radius on the inside is not less than 3 times the thickness of the flange immediately adjacent thereto, AND WHERE THE RIVETING MEETS ALL THE REQUIREMENTS FOR CIRCUMFERENTIAL JOINTS GIVEN IN PARS. P-181 TO P-185,"

PAR. P-198*a*. Add the following:

"$C = 0.50$ for plates having a dimension *d* not exceeding 18 in. inserted into shells, pipes, or headers and welded thereto as shown in Fig. P-14½*i* and otherwise meeting the requirements for

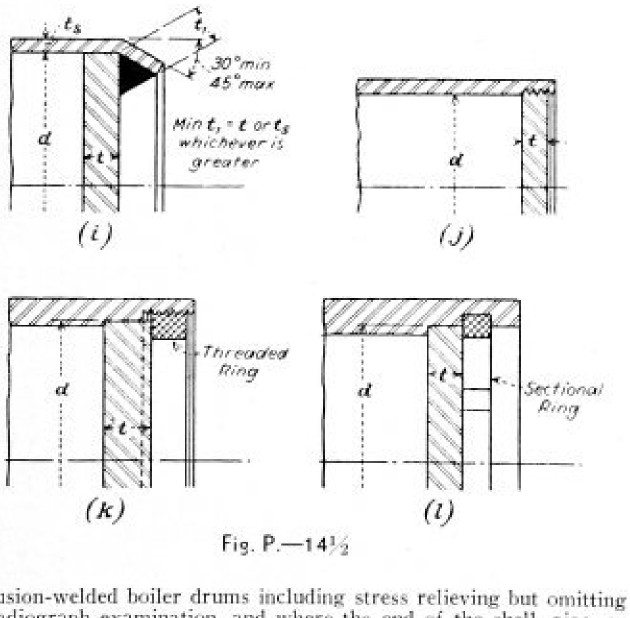


Fig. P.—14½

fusion-welded boiler drums including stress relieving but omitting radiograph examination, and where the end of the shell, pipe, or header is crimped over to an angle not less than 30 deg nor more than 45 deg, the crimping is done cold only when this operation will not injure the metal, and the throat of the weld is not less than the thickness of the shell, pipe or header wall or flat head, whichever is greater,"

PAR. U-39*a*. Add the following:

"$C = 0.50$ for plates having a dimension *d* not exceeding 18 in. inserted into vessels and welded thereto as shown in Fig. U-2*i* and otherwise meeting the requirements for the respective types of fusion-welded vessels including stress relieving when required for the vessel but omitting the radiograph examination, and where the end of the vessel is crimped over to an angle not less than 30 deg. nor more than 45 deg. the crimping is done cold only when this operation will not injure the metal, and the throat of the weld is not less than the thickness of the vessel wall or flat head, whichever is greater."

PARS. P-198*a* and U-39*a*. Add the following:

"$C = 0.75$ for plates screwed into the end of a shell, pipe, or header (vessel) having an inside diameter *d* not exceeding 12 in., as shown in Fig. P-14½*j* (U-2*j*), where the hydrostatic end pressure on the head is resisted with a factor of safety of 5 both by the threads engaging the flat head and shell, pipe or header (vessel) wall and by the reduced cross-section of the threaded portion of the shell, pipe, or header (vessel). Seal welding may be used, if desired,"

PARS. P-198*a* and U-39*a*. Add the following:

"$C = 0.30$ for plates inserted into the end of a shell, pipe, or header (vessel) and held in place by some suitable positive mechanical-locking arrangement such as shown in Fig. P-14½*k* and *l* (U-2*k* and *l*), where all possible means of failure, either by shear, tension, or compression, due to hydrostatic end force are resisted with a factor of safety of 5. Seal welding may be used, if desired."

PAR. P-214. Add the following sentence:

"The rules in Par. P-216 shall be used to determine if staying is required."

PARS. P-268*d* and U-59*v*. Modify proposed revisions appearing in the April issue to read as follows but insert as item (3) of fifth section of Par. P-268*b* and as item (3) of Par. U-59*g*:

["*d* (*v*)] (3) NO CREDIT CAN BE TAKEN FOR THE ADDITIONAL STRENGTH OF MATERIAL HAVING A HIGHER TENSILE STRENGTH THAN THAT OF THE VESSEL WALL TO BE REINFORCED.

If the unit tensile strength of any material used for reinforcement is not AT LEAST equal to that of the vessel wall to be reinforced, additional reinforcement shall be added to compensate for the lower tensile strength, so that the total area of the cross-section of the reinforcement is in inverse proportion to the tensile strength."

TABLE A-6. In the 150-lb. column for the minimum metal thickness of fitting, for the 1-in., 1¼-in. and 1½-in. sizes change dimension "7/16" to "¼.*" Also add a footnote to read: "*7/16 in. is recommended in A.S.A. Standard B-16e—1932."

PAR. A-21*a*. Revise last three lines to read:

"is 13 in. or less, the [bottom of the] fusible plug may BE [come] at a lesser distance than 1 in. above the upper row of tubes, but in no case shall the BOTTOM OF THE plug be located below the level of the top of the uppermost row of tubes."

PAR. H-67. Revise to read:

"H-67. Each plate of a completed boiler shall bear the plate maker's name with brand and tensile strength. [except that these marks need not appear on the butt straps after completion of boiler.] IF THE BOILER IS INSPECTED DURING CONSTRUCTION AND THE INSPECTOR ASSURES HIMSELF THAT THE PLATE MATERIAL CONFORMS TO CODE REQUIREMENTS, THE PLATE MAKER'S MARKS NEED NOT APPEAR AFTER COMPLETION OF THE BOILER."

PAR. H-81. Revise first sentence to read:

"Every boiler [the unsupported joints of] IN WHICH THE PARTS SUBJECTED TO STRESSES DUE TO INTERNAL PRESSURE are JOINED [welded] by MEANS OF [the] fusion WELDING [process] shall

TABLE U-1A MAXIMUM ALLOWABLE WORKING EXTERNAL PRESSURES FOR SEAMLESS AND LAP-WELDED STEEL TUBES FOR UNFIRED PRESSURE VESSELS FOR DIFFERENT DIAMETERS AND GAGES OF TUBES CONFORMING TO THE REQUIREMENTS OF SPECIFICATIONS S-17

Outside diameter of tube in inches,	Minimum gage—B. w. g.													
	17	16	15	14	13	12	11	10	9	8	7	6	5	4
D	$t=$ 0.058	$t=$ 0.065	$t=$ 0.072	$t=$ 0.083	$t=$ 0.095	$t=$ 0.109	$t=$ 0.120	$t=$ 0.134	$t=$ 0.148	$t=$ 0.165	$t=$ 0.180	$t=$ 0.203	$t=$ 0.220	$t=$ 0.238
½	300	...	...	...	...	...	...	...	...	...	...	...	...	...
¾	165	450	...	...	...	...	...	...	...	...	...	...	...	...
1	100	300	500	...	...	...	...	...	...	...	...	...	...	...
1¼	...	225	390	...	...	...	...	...	...	...	...	...	...	...
1½	...	175	305	445	...	...	...	...	...	...	...	...	...	...
1¾	...	140	250	365	485	...	...	...	...	...	...	...	...	...
2	...	110	210	305	405	...	...	...	...	...	...	...	...	...
2¼	...	...	175	260	350	440	...	...	...	...	...	...	...	...
2½	...	...	150	230	305	390	460	...	...	...	...	...	...	...
2¾	...	...	130	200	270	345	420	490	...	...	...	...	...	...
3	...	...	115	175	240	305	375	440	...	...	...	...	...	...
3¼	...	...	...	155	215	275	340	400	460	...	...	...	...	...
3½	...	...	...	...	190	250	310	370	425	480	...	...	...	...
3¾	...	...	...	...	160	210	270	340	390	445	495	...	...	...
4	...	...	...	...	...	180	240	300	360	405	455	...	...	...
4½	...	...	...	...	...	135	180	240	295	350	400	445	485	...
5	...	...	...	...	...	...	135	185	240	290	350	390	430	470

The above table is based on the formula

$$\text{Tube gage} = 18 - [1.33 + 0.005\,(P\text{-}175)\,D$$

but in no case is the tube-wall thickness less than that determined by the following formula:

$$t = \frac{(P + 275)D}{17{,}300}$$

where t = tube-wall thickness, in., P = maximum possible difference in pressure between the outside and inside of the tube at any time, lb. per sq. in., D = outside diameter of tube, in.

These rules may be followed for determining values intermediate of those given in the table and for values beyond the limits of the table.

be inspected during [its] construction at the shop where manufactured, by AN [a duly] authorized inspector."

PAR. U-13. Add the following as *e:*

(*e*) Tubes conforming with Specifications S-17 for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes may be used in unfired pressure vessels. The minimum gage thickness for such tubes for temperatures not exceeding 700 F, if under external pressure shall be as given in Table U-1A, and if under internal pressure shall be as given in Table U-1B.

PAR. U-13. Add the following as *f:*

"*f* Non-ferrous tubes conforming with Specifications S-29, S-30, and S-31 may be expanded or threaded into unfired pressure vessels."

PAR. U-22. Delete.

Par. U-23. Renumber as Par. U-22 and insert the following as new Par. U-23:

"U-23. Pressure vessels and pressure parts of vessels may be fabricated by means of electric-resistance butt welding when the rules given in Pars. U-110 to U-114 are followed."

PAR. U-39*a*. Revise definitions as follows:

"$C = 0.25$ for heads forged integral with or butt welded to shells or pipes as shown in Fig. U-2*d* and *e*, where the corner radius on the inside is not less than 3 times the thickness of the flange immediately adjacent thereto, AND WHERE THE WELDING MEETS ALL THE REQUIREMENTS FOR CIRCUMFERENTIAL JOINTS GIVEN IN PARS. U-67 TO U-79, INCLUDING THOSE FOR STRESS RELIEVING AND RADIOGRAPH EXAMINATION."

"$C = 0.30$ for flanged plates attached to shells or pipes as shown in Fig. U-2*c* by means of CIRCUMFERENTIAL lap joints RIVETED, FUSION-WELDED OR BRAZED AND MEETING ALL THE REQUIREMENTS THEREFOR, INCLUDING THOSE FOR STRESS RELIEVING OF FUSION-WELDED JOINTS, and where the corner radius on the inside is not less than 3 times the thickness of the flange immediately adjacent thereto,"

PARS. U-69*a* and U-70*a*. Revise the wording of the parenthetical matter at the end of Pars. U-69*a* (page 57) and U-70*a* (page 62) to read:

"A RECOMMENDED FORM FOR RECORDING THE QUALIFICATION TESTS OF WELDING OPERATORS [sample data report sheet] appears on page 73;" and the heading of the form on page 73 to read: "RECOMMENDED FORM FOR MANUFACTURER'S RECORD OF QUALIFICATION TEST OF WELDING OPERATORS [DATA REPORT FOR VESSELS CONSTRUCTED IN ACCORDANCE WITH PARS. U-69 AND U-70.]"

PAR. U-73*f*. Revise to read:

"*f* Flat heads may be welded into any pressure vessel under the rules given in Par. U-39*a* [provided the welding meets the requirements for fusion welding for the class of service intended, except that radiograph examination may be omitted. When the fusion-welded vessel must be stress relieved, the flat head shall also be stress relieved.]"

PARS. U-110 to U-114. Insert the following new paragraphs:

RULES FOR ELECTRIC-RESISTANCE BUTT WELDING

"U-110. The plate for any part of a vessel to be welded by electric-resistance welding shall be of quality in accordance with Specifications S-2 for Steel Plates of Flange and Firebox Qualities for Forge Welding.

U-111. Where the entire area is welded simultaneously, without the introduction of extraneous metal, the maximum allowable unit working strength of the joint shall be 8000 lb. per sq. in. The finished weld shall be annealed preferably before removing from the welding machine.

U-112. Where the weld is made progressively and continuously over its entire length, the thickness of plate shall not exceed 0.15 in., and the offset of the edges, after welding, shall not exceed 60 per cent of the thickness of the plate. The maximum allowable unit working stress shall be 8000 lb. per sq. in.

Prior to the welding operation by this method, the edges of the plate and the electrical contact area shall be cleaned so as to free those surfaces from scale, oxide, or grease.

U-113. For temperatures higher than 700 F, the working stress allowable on electric-resistance-welded joints shall be reduced in proportion to the scale of reduction given in Table U-3.

U-114. Vessels whose joints are made by electric-resistance butt welding shall be tested in accordance with Par. U-64."

PAR. UA-16*b*. Revise last sentence to read:

"These rules may be applied to flanges of any diameter and for any working pressure, BUT ARE NOT INTENDED TO APPLY TO FLANGED CONNECTIONS WITH GASKETS EXTENDING BEYOND THE BOLT CIRCLE."

PAR. UA-22*b*. Revise first sentence to read:

"*b* Ring flanges may be fusion welded to a cylindrical shell or nozzle neck as shown in Fig. UA-2*d* AND CONSIDERED AS AN INTEGRAL FLANGE, provided that:"

TABLE U-1B MAXIMUM ALLOWABLE WORKING INTERNAL PRESSURES FOR SEAMLESS AND LAP-WELDED STEEL TUBES FOR UNFIRED PRESSURE VESSELS FOR DIFFERENT DIAMETERS AND GAGES OF TUBES CONFORMING TO THE REQUIREMENTS OF SPECIFICATIONS S-17

Outside diameter of tube in inches,	Minimum gage—B. w. g.													
	19	18	17	16	15	14	13	12	11	10	9	8	7	6
D	t= 0.042	t= 0.049	t= 0.058	t= 0.065	t= 0.072	t= 0.083	t= 0.095	t= 0.109	t= 0.120	t= 0.134	t= 0.148	t= 0.165	t= 0.180	t= 0.203
½	350	...	...	...	...	...	...	...	...	...	...	...	...	...
¾	140	360	...	...	...	...	...	...	...	...	...	...	...	...
1	...	210	375	...	...	...	...	...	...	...	...	...	...	...
1¼	...	100	250	400	...	...	...	...	...	...	...	...	...	...
1½	...	...	160	290	420	...	...	...	...	...	...	...	...	...
1¾	...	...	...	210	325	450	...	...	...	...	...	...	...	...
2	...	...	...	145	250	305	470	...	...	...	...	...	...	...
2¼	...	...	...	...	190	290	390	490	...	...	...	...	...	...
2½	...	...	...	...	140	235	325	425	...	...	...	...	...	...
2¾	...	...	...	...	100	185	275	360	460	...	...	...	...	...
3	...	...	...	...	...	150	230	310	400	490	...	...	...	...
3¼	...	...	...	...	...	115	195	270	350	445	...	...	...	...
3½	...	...	...	...	...	...	155	235	310	390	475	...	...	...
3¾	...	...	...	...	...	...	125	200	270	345	435	...	...	...
4	...	...	...	...	...	...	100	170	240	310	385	470	...	...
4½	...	...	...	...	...	...	...	120	180	250	320	385	465	...
5	...	...	...	...	...	...	...	...	140	200	265	325	395	470

The above table is based on the formula, $t = \frac{(P+250)D}{20{,}800} + 0.026$

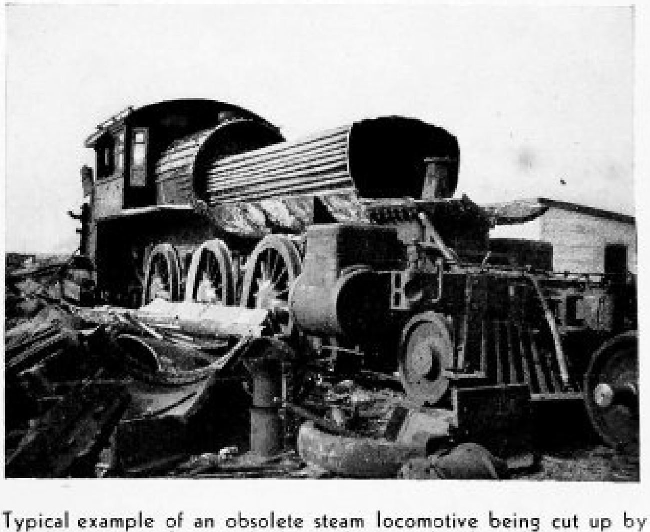
where t = tube-wall thickness, in., P = internal pressure, lb. per sq. in., D = outside diameter of tube in.

These rules may be followed for determining values intermediate of those given in the table and for values beyond the limits of the table but not in excess of 1000 lb. pressure for seamless steel tubes or 500 lb. pressure for lap-welded steel or wrought-iron tubes.

Maximum Profits from Scrapping Equipment

During the past few years, the railroads of the United States have dismantled and sold as scrap thousands of locomotives and tens of thousands of freight cars. During the coming years, particularly with a return to normal traffic volume, they will scrap other thousands of units of equipment which, due to age and design, do not fit into modern transportation.

The disposal of these locomotives and cars in the most advantageous way presents a problem to the rail-



Typical example of an obsolete steam locomotive being cut up by the oxy-acetylene method in such a way that the railroad can realize maximum returns from the scrap road management. When a number of units of equipment are to be disposed of, the choice of three procedures is presented. The equipment can be sold on its wheels to the scrap dealer; it may be dismantled by the railroad and the materials reduced to convenient loading size; or all of the materials contained may be cut to charging box size and sorted to grades, as required by the ultimate consumer, the steel mill.

If the first option is selected, it is obvious that the amount received for the equipment will represent a price per ton which will permit the buyer to pay the cost of dismantling, cutting to charging box size, sorting to grade and provide a profit to him over all expense involved in performing these operations.

If the second plan is followed, the railroad derives some additional revenue from the transaction through securing a higher price per ton for the materials involved, such added revenue being more than sufficient to cover the cost of dismantling the equipment and handling the scrap. Additionally, under this plan, the railroad is ordinarily able to save a number of parts which may be put to further use and which, under the first plan, would be sold at scrap prices and must either be repurchased at a substantial increase in price or lost.

When the third option is adopted, the railroad itself, under a carefully planned procedure, dismantles the equipment, cuts the scrap to charging box size and sorts to classification. In this case, it secures from the sale of the scrap the highest market price and saves for itself all of the profit incident to the necessary operations of dismantling, cutting and handling.

While many of the railroads in years past have followed the practice of cutting all of their scrap to charging box size, profiting substantially thereby, many roads still sell their equipment on wheels or merely dismantle to loading size and also dispose of the miscellaneous scrap which accumulates on the same basis. Such roads are obviously overlooking an opportunity to increase their earnings by no small amount through taking advantage of the differential which always exists between the price of miscellaneous scrap materials and the price of the same materials when properly cut and graded.

A recent study on one of the railroads indicates just how much may be realized by cutting locomotives to steel mill classification instead of selling them on wheels or disposing of the material in loading size. The following figures show the results of a carefully conducted test designed to determine the most profitable method of handling a locomotive scrapping program:

Profit Resulting from Cutting 100-Ton Locomotive and Tender to Charging Box Size

	Selling price per g.t.	Cost of preparing scrap per g.t.	Net price to railroads per g.t.	Net profit to railroad on 100-ton locomotive
On wheels	$7.28	$....	$7.28	$.....
Loading size	9.22	1.33	7.89	61.00
Charging box size..	11.63	2.43	9.20	192.00

Due to constant fluctuations of the scrap market and to the variations obtaining in different sections of the country, the figures given would, of course, apply only at a particular time and in a particular locality. However, while the scrap market varies from day to day and from place to place, the differential between cut and uncut scrap remains fairly constant and, while the profit in dollars would vary from time to time and from road to road, the percentage of profit secured by reducing scrap to charging box size remains constant.

The expense involved in cutting, sorting and handling the scrap will, of course, depend largely upon the facilities available. Very few railroads, however, are not fully equipped to take care of this work in an economical manner. All that is required is shop or yard room where the equipment can be dismantled without interfering with other operations; oxy-acetylene cutting equipment for performing the dismantling operations in a minimum time and at the lowest possible cost and for cutting the parts to proper size; a locomotive crane for loading the materials and, if available, a large shear for reducing the light sheets such as are contained in the tank to charging box size.

The locomotive to be dismantled should be laid out for the cutters in such a way as to require the minimum amount of cutting to reduce all parts to the desired dimensions. The best procedure after stripping pipes and appurtenances is to start the oxy-acetylene cutters on top of the boiler. These men can then cut their way down toward the rails with the minimum amount of lost time and with the least possible handling of materials. Very little crane service is required during the cutting operation when this procedure is followed. After the locomotive has been reduced to charging box material, the crane crew can classify the material as it is loaded, thereby avoiding any additional handling.

Durstine Receives First Agency Certificate Awarded By Business Publishers

Roy S. Durstine, acting for the advertising agency, Batten, Barton, Durstine & Osborn, of which he is vice-president, received the first certificate of Agency Recognition ever awarded by The Associated Business Papers, Inc., at a meeting of 125 representatives and publishers of this association, held at the Lotos Club, New York, May 27, 1935. Presentation was made by President Everit Terhune, of the A.B.P.

In presenting this certificate, President Terhune expressed the satisfaction of A.B.P. members at the friendliness and spirit of fair play which marked the attitude of this agency toward the business press.

Practically every account, whose advertising is handled by his agency, believes in and makes use of business paper space as an essential part of its advertising program, Mr. Durstine said, in accepting the certificate. It is because of this policy, he alleged, that Batten, Barton, Durstine & Osborn placed more pages of advertising with member publications of The Associated Business Papers than any other agency in the land during each of the past four years.


President Terhune of the A. B. P. Presenting the Certificate to Mr. Durstine

Approximately two hundred and fifty other advertising agencies in this country, now meeting requirements of The Associated Business Papers for recognition, are to receive their certificates of agency recognition in the near future.

Boiler Maker and Plate Fabricator

VOLUME XXXV NUMBER 6

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This is to certify that the average circulation per issue of BOILER MAKER & PLATE FABRICATOR for the six months period July 1 to and including December 31, 1934, was as follows: Copies sold 2,168. Copies distributed free 681. Total 2,849. Signed H. E. McCandless, Circulation Manager, Simmons-Boardman Publishing Company. Subscribed to and sworn before me on this 12th day of April 1935. Henry D. Nelson, Notary Public, Queens County, N. Y.

Request for change of address should reach us on or before the 15th of the month preceding the issue with which it is to go into effect. It is difficult and often impossible, to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address, please be sure to send us your old address as well as the new one.

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EDITORIAL STAFF: H. H. Brown, Editor. L. S. Blodgett, Managing Editor

Contents

Republic Official Addresses Purchasing Agents

"High Hat Steels and How to Sell Them" was the title of an address delivered before the Iron and Steel Group of the National Association of Purchasing Agents Wednesday, May 22, at the Waldorf-Astoria Hotel, New York City, by S. A. Knisely, advertising and sales promotion manager of Republic Steel Corporation, Youngstown, O.

Mr. Knisely traced briefly the development of modern special steels, or "high hat steels," as he termed them, and pointed out that these steels have been produced to satisfy the demands of the purchasing agent and his technical consultants. He also brought out the fact that the old-fashioned type of "hard-boiled" purchasing agent has been replaced with a new type—the purchasing agent with an open mind and a willingness to listen to intelligent presentation of facts. Mr. Knisely then explained how Republic Steel Corporation is training its salesmen to be of maximum assistance to purchasing agents who buy "high hat steels."

Consulting Engineer Appointed for Hollup Corporation

A. M. Candy, nationally known arc-welding authority, has been appointed consulting engineer on the staff of the Hollup Corporation, Chicago, manufacturers of welding wire and supplies.

Mr. Candy will be engaged in the development of welding machines and other equipment, and research and development work in improved welding practice. His work will be an extension of the intensive research and development work in welding carried on by the Hollup research laboratories.

Mr. Candy is a graduate of the University of Nebraska with a degree in electrical engineering, and has been associated with Westinghouse Electric & Manufacturing Company for many years. In the Westinghouse engineering department he has been engaged in the solution of electrical problems involving motion picture projection, storage battery locomotives, and arc welding.

Trade Publications

Arc Welder.—Ideal Electric & Manufacturing Company, Mansfield, O., has prepared a 16-page booklet, bulletin No. 910, on its Noel speed-arc welder. Claims for this device are high power factor, high efficiency and high speed, all tending to reduce cost to the user. It is well illustrated.

Balancers.—The Independent Pneumatic Tool Company, Chicago, announces a complete line of Thor perfect balancers in capacities up to and including 200 pounds. The Thor tapered drum, one of the outstanding features of modern balancer construction is applied to the entire line and assures perfect balance of the load at any point within the range of travel. Four sizes in the Thor line of balancers are equipped with a locking and unloading device.

Industrial Compressors.—A catalogue covering "Type 30" industrial compressors and vacuum pumps has been issued by Ingersoll-Rand Company, New York. The compressors described include single-stage, single and twin-cylinder and two-stage machines. Either automatic start and stop or constant speed control is used depending upon the type of service. The compressors are listed with vertical or horizontal receivers and with electric motor, gasoline engine or belt drive.

Costs and Profits.—Under the title "Costs and Profits in Manufacturing Industry 1914-1933" the National Industrial Conference Board, Inc., New York, has issued a booklet giving a preliminary analysis of costs and profits, tracing the changes that have occurred from 1914 to 1933 in the distribution of manufacturer's receipts. The facts presented are of importance in consideration of the many current questions of public policy which involve the ability of private manufacturing enterprises to adjust themselves to additional burdens imposed by government.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on practical boiler shop problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given special permission to do so.

By George M. Davies

Burning Soot Off Boiler Tubes

Q.—Are there any successful methods of burning soot off the tubes of watertube boilers, which will clean them and thus avoid the need for soot blowing and hand cleaning?—B. L.

A.—There have been developed during the past few years various compounds which, when introduced into the furnaces or blown on to the tubes where soot is collecting, will initiate a combustion which will convert a good deal of the soot into ash which drops by itself or is more easily removed. These compounds in many cases contain zinc or a zinc oxide which will cause the burning or disintegration of the soot to a certain extent. It is accomplished by acting on the carbon deposit and lowering its ignition temperature. The most successful of these are probably effective and inexpensive enough to justify their use on marine boilers where rather undesirable soot deposits from certain fuel oils are formed.

The effectiveness of such soot burning applications will most likely be very much improved when some definite method of bringing the powder or gas which acts upon the soot to definitely impinge upon or come into contact with the surfaces where the soot has accumulated. The amount of the compound required and its cost would, of course, have to be considered against its effectiveness, in keeping the soot from accumulating.

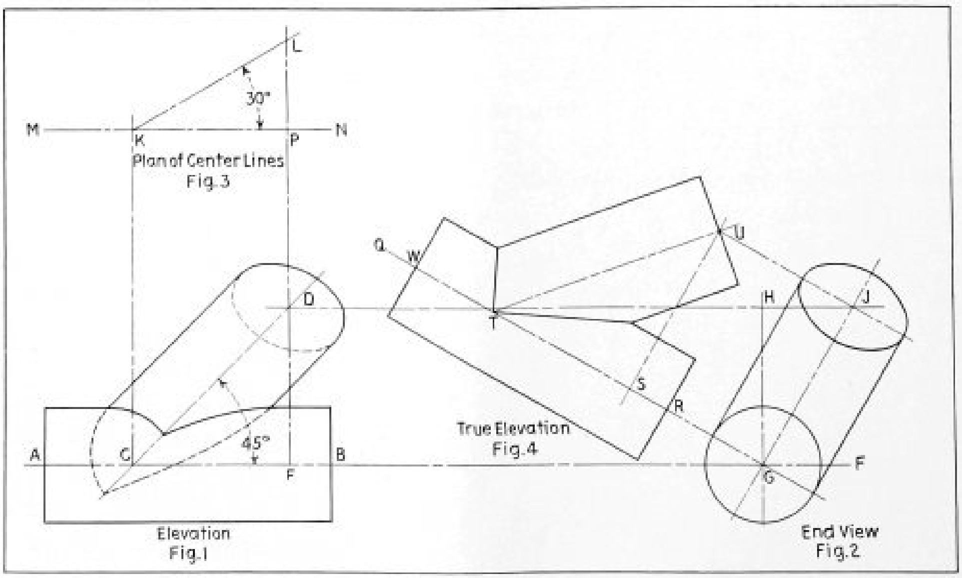
Among the soot-burning compounds now being marketed are "Knox-Soot," Visco Chemical Products Company, Cleveland, O., which is introduced into the furnace by means of a special air gun. This has been used with success on several vessels. "OXI," marketed by Walters Manufacturing Company, St. Louis, Mo., is intended to secure similar results.

Welding Instructions—Compound-Y Connection

Q.—In the March issue I noticed straps welded to the sides of the Y-section in the article "Practical Plate Development," page 58. Would you explain their purpose? Are the plates for this Y-section cut to the proper outline, then rolled or are they rolled up then cut by torch? What method would be used in laying out a compound Y connection having a 45-degree angle in the elevation and a 30-degree angle in the plan?
W. B.

A.—The straps referred to in the question, as shown in the illustration of fabricating a Y-section, in the March issue, are no doubt used to secure the pipes in position when assembling same.

The A.S.M.E. Code provides the following in connection with the preparation for welded seams:



Method of laying out a compound Y connection

Consulting Service on Boiler Patches

Requests for information and assistance on the design and application of boiler patches are received from time to time by the Questions and Answers Department; but, due to the fact that complete information is not given, a satisfactory answer cannot be made.

With this announcement a new service to our readers is being inaugurated. When a question arises as to the efficiency of a patch to meet a particular repair requirement, send the necessary data, as outlined below, to BOILER MAKER AND PLATE FABRICATOR. The patch design will be checked promptly and the information regarding it transmitted to the questioner within a short time. The solution will be published later.

Rules for the design of boiler patches must of necessity be of a general nature so as to include as far as possible all the various styles and shapes of patches that can be used.

Each boiler patch, however, is an individual problem due to the fact that the size of the crack and the construction around the cracked portion of the shell are different with each boiler.

In order that inquiries for information on the design of boiler patches can be given the best possible solution, it is necessary that each inquiry contain all the data required for computing the efficiency of the patch itself, and also for checking the patch for strength in its relation to the boiler construction surrounding the patch.

The information required should be listed as follows:

1.—Working pressure of boiler.

2.—Factor of safety.

3.—Efficiency of longitudinal seam of course to which the patch is to be applied. (When this is not known, a sketch should be submitted showing unit section of seam fully dimensioned.)

4.—Thickness of shell course to which patch is applied.

5.—Sketch of proposed patch showing the following:

a.—Complete detail dimensions of patch.

b.—Length of crack in shell, longitudinally.

c.—Sketch should include all the holes in the shell outside of the patch, within a distance equal to the pitch of the rivets on the outside row of the longitudinal seam of the course to which the patch is applied.

Preparation for Welding: The plates or sheets to be joined shall be accurately cut to size and formed. In all cases the forming shall be done by pressure and not by blows, including the edges of the plates forming longitudinal joints of cylindrical vessels.

Particular care should be taken in the layout of joints in which fillet welds are to be used so as to make possible the fusion of the weld metal at the bottom of the fillet. Great care must also be exercised in the deposition of the weld metal so as to secure satisfactory penetration.

The edges of the plates at the joints shall not have an offset from each other at any point in excess of one-quarter of the thickness of the plate, except for plates in excess of ¾ inch in thickness, in which the offset shall not be more than 10 percent (maximum ⅛ inch) for longitudinal joints, or 25 percent (maximum ¼ inch) for girth joints.

In all cases where plates of unequal thicknesses are abutted, the edge of the thicker plate shall be reduced in some manner so that it is approximately the same thickness as the other plate.

The design of welded vessels shall be such that bending stresses are not brought directly upon the welded joint. Corner welds shall be avoided unless the plates forming the corner are properly supported independently of such welds.

Bars, jacks, clamps or other appropriate tools may be used to hold the edges to be welded in line. The edges of butt joints shall be so held that they will not overlap during welding. Where fillet welds are used, the lapped plates shall fit closely and be kept together during welding.

The surfaces of the sheets or plates to be welded shall be cleaned thoroughly of all scale, rust, oil, or grease for a distance of not less than ½ inch from the welding edge. Grease or oil may be removed with gasoline, lye, or the equivalent. A steel-wire scratch brush may be used for removing light rust or scale, but for heavy scale, slag, and the like, a grinder, chisel, air hammer, or other suitable tool shall be used to obtain clean and bright metal. When it is necessary to deposit metal over a previously welded surface, any scale or slag therefrom shall be removed by a roughing tool, a chisel, an air chipping hammer, or other suitable means to prevent inclusion of impurities in the weld metal.

The dimensions and shape of the edges to be joined shall be such as to allow thorough fusion and complete penetration.

For double-welded butt joints the reversed sides shall be chipped, ground, or melted out, so as to secure a clean surface of the originally deposited weld metal, prior to the application of the first bead of welding on the second side. Such chipping, grinding, or melting out shall be done in a manner that will insure proper fusion of the weld metal.

If the welding is stopped for any reason, extra care shall be taken in re-starting to get full penetration to the bottom of the joint and thorough fusion between the weld metal and the plates, and to the weld metal previously deposited.

Where single-welded butt joints are used, particular care shall be taken in alining and separating the edges to be joined so that complete penetration and fusion at the bottom of the joint will be assured.

Compound-Y Connection

To develop a compound-*Y* connection having a 45-degree angle in the elevation and a 30-degree angle in the plan:

Lay out the elevation as shown in Fig. 1, E-C-D being a 45-degree angle. Next draw the line *M-N*, Fig. 3, parallel to *A-B* and at the points *C* and *E* erect perpendiculars to *A-B* cutting *M-N* at *K* and *P*.

From *K* draw *K-L* at 30 degrees to *M-N*, the line *K-L* cutting the perpendicular to the point *E* at *L*.

Next extend *A-B* to *F* and at any point as *G*, Fig. 2, erect a perpendicular to *A-F*. Then draw a line through the point *D*, Fig. 1, parallel to *A-F*, cutting the perpendicular just drawn at *H*. From *H* step off the distance *H-J* equal to *P-L*, Fig. 3; draw the line *G-J*, which will be the true height of the connection piece.

Then erect a perpendicular to *G-J* at *G* as *G-Q*. On *G-Q* step off the distance *S-R* equal to *E-B*, Fig. 1, *S-T* equal to *C-E*, Fig. 1, and *T-W* equal to *A-C*, Fig. 1; and at *S* erect a perpendicular to *G-Q*.

Then erect a perpendicular to *J-G* at *J*, cutting the perpendicular just drawn locating the point *U*. Connect *U-T*, completing the center lines of the true elevation as shown in Fig. 4. Complete the elevation as shown.

Fig. 4 will be the elevation and Fig. 2 the end view of the compound-*Y* connection, all dimensions being in their true length.

The connection is then developed by the method outlined in the March issue.

Steam Dome Problem

Q.—Concerning the problem "Attaching Steam Dome to Boiler" in the May issue, we would appreciate a bit more information.

First, $A°$ = angle of rivet spacing $= \dfrac{360}{40} = 9$ degrees.

We do not understand how this is arrived at, as we understood *P* to be the rivet pitch, and that may be the source of some trouble in working out a design we have in mind. It seemed to us that the angle would be anything from 40 degrees to 85 degrees. How do you get the 9 degrees? We used *P* = actual rivet pitch, so in this case it would be about 1⅞ inches rather than 3¾ inches. This is probably where we made our error, so we would like a more complete explanation of arrival at value for P_1.

Second: It was our understanding that the efficiency of the diagonal ligaments under rule 1 of Par. P-193h had to be at least equal to the efficiency of the shell, or in this case 93.3 percent, whereas it is shown to be 88.2 percent. We thought this would condemn the construction.

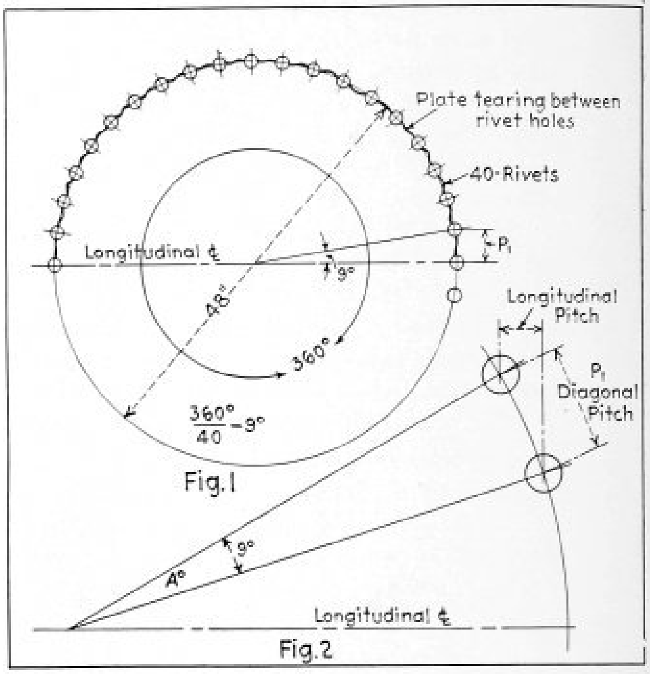
Third: Is it necessary to calculate only one row of rivets, or both rows, and also the diagonal ligaments between rows?

We thank you for the illustration already published and we believe that answers to our questions herein would clear it up for us. R. D.

A.—(1) In the problem "Attaching Steam Dome to Boiler" in the May issue, the angle $A°$ is the angle made by connecting the center of each of the rivets to the center of the rivet circle as illustrated in Fig. 1.

There being 360 degrees in a circle and forty rivet spaces, the angle formed by connecting the centers of two adjacent rivet holes to the center of the rivet circle would be 360 ÷ 40 or 9 degrees.

In order to understand the value of P_1, it must first be understood that the efficiency we are seeking is the efficiency of the shell course through the rivet holes of the



Rivet details for applying steam dome

outside row of rivets which secure the collar to the shell. We are considering the tearing of the shell plate through the rivet holes as illustrated in Fig. 1.

P_1 is the diagonal pitch in that it is at a diagonal to the longitudinal pitch in all positions on the circle, as illustrated in Fig. 2.

P_1, the diagonal pitch, is the same for all positions, and is the chord of the arc formed by the angle of 9 degrees and is equal to $P_1 = 2R \times \text{sine}\ \dfrac{A°}{2}$

$P = 2 \times 24 \times 0.0784 = 3.75$ inches

A simple check would be to compare this pitch with the circumference of a 48-inch diameter circle.

Circumference of 48-inch diameter circle = 150.796 inches

40 - 3.75-inch spaces = 40 × 3.75 = 1500 inches

(2) The statement that the design meets the requirements of Par. P-193c is in error. In order to comply with rule (1) of Par. P-193c the efficiency would have to be at least equal to the efficiency on which the maximum allowable working pressure is based or 93.3 percent.

In order to produce this efficiency it would be necessary either to reduce the diameter of the rivets, the number of rivets used, or increase the diameter of the rivet circle.

(3) It is always the best rule to calculate all possible methods of failure, however it will be noted in this case, that when computing the inside row of collar rivets, the outside row of collar rivets will be in shear, supporting the shell from tearing through the rivets of the inside row.

Associations

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Assistant Chief Inspectors—J. M. Hall, Washington, D. C.; J. A. Shirley, Washington, D. C.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

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Office of Industrial Recovery Committee, 15 Park Row, New York

Manager—James D. Andrew.

Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President—Murrel J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

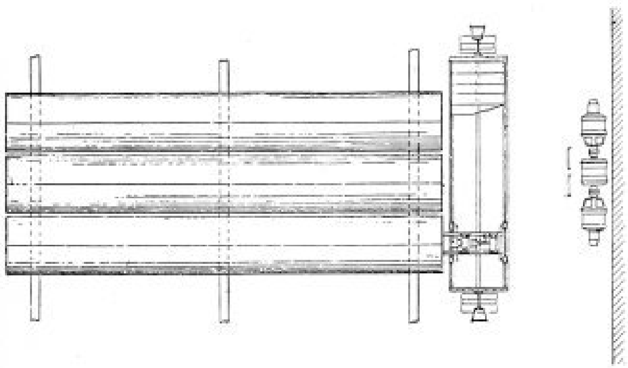
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent Attorney, 1372-1376 National Press Building, Washington, D. C. Readers wishing copies of patents or any further information regarding any patent described, should correspond directly with Mr. Galt.

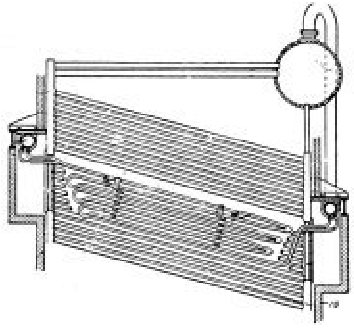
1,884,826. ELECTRIC WELDING MECHANISM. CECIL C. PECK, OF LAKEWOOD, AND MAURICE R. TAYLOR, OF EAST CLEVELAND, OHIO, ASSIGNOR TO THE LINCOLN ELECTRIC COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

Claim.—In combination, a bed upon which articles to be welded are supported; a self propelled welding apparatus supported by and traveling



directly upon the articles to be welded; and vertically and transversely movable means adjacent said bed for conveying said welding mechanism from one such article to another. Three claims.

1,883,931. SUPERHEATER BOILER. JAMES F. KAVANAGH, OF CALUMET CITY, ILLINOIS, ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y.



Claim.—In a boiler, the combination of a plurality of spaced banks of steam generating tubes each comprising rows of tubes, headers connected to corresponding ends of the several rows in a bank, alternate headers at each end of the boiler and associated with one of the banks being extended towards another bank of said plurality, steam generating tubes connecting the extended portions of corresponding headers, and a superheater arrangement disposed between the tubes connecting the extended portions of the alternate headers. Twelve claims.

1,881,879. STEAM BOILER. ERNEST EDWARD NOBLE, OF FULWELL, SUNDERLAND, ENGLAND, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

Claim.—In a low head bent tube boiler and its furnace, an upper drum, a lower drum, a first bank of tubes freely exposed throughout practically all of their lengths to radiant heat from the furnace and bent in different degrees at their ends so that they enter both drums radially, the tubes being bent intermediate their terminal bends to provide horizontally inclined sections extending from the lower drum transversely of the furnace to upright tube sections located between vertical planes bounding the upper drum and extending to the upper bent ends to utilize a density differential which induces in the horizontally inclined sections a flow sufficient to prevent excessive heat damage, a superheater located immediately above the horizontally inclined tube sections, and a second bank of tubes joining the drums and shielded from radiant heat from the furnace only by the first bank of tubes and the superheater. Three claims.

Boiler Maker and Plate Fabricator

Master Boiler Makers Arrange Program for Meeting

Regardless of any action that may be taken by the group of minor railway mechanical associations towards holding co-ordinated business meetings at Chicago in September, the Master Boiler Makers' Association is proceeding independently with its plans for bringing together as many of the officers, committee members and members of the association as is possible through permission of their respective superior mechanical officers.

To the end that this meeting may produce information of real benefit to the railroads in meeting the serious problems involved in certain aspects of locomotive boiler inspection, maintenance and repair, a program of extremely practical papers is now in course of preparation by committees of the association, covering the following subjects: "Boiler and Tender Tank Corrosion and Pitting, in Service and in Storage;" "Fusion Welding as Now Applied to Boilers and Tenders;" "Staybolt Leakage and Cracking of Firebox Sheets—Methods of Prevention;" "Application and Maintenance of Arch and Watertubes;" special report of the Southern Pacific Company on "Fusible Plugs."

Apprentice Schools Should Be Established

One of the most serious problems confronting industry in general, and the boiler and pressure vessel manufacturing fields in particular, is that of the future availability of men qualified to become supervisors and skilled artisans. While boiler production and pressure vessel fabrication have become more and more exact mechanical processes, the ranks of those experienced in the technique have been gradually depleted. Steps must be taken without loss of time to make up for this deficiency which, already troublesome, gives every evidence of becoming acute in a very few years.

Practically all industrial concerns in the past having extensive establishments, as well as many smaller ones, have organized and supported schools for apprentice training in which were developed skilled craftsmen and potential supervisors so necessary to successful operation. With but few exceptions, this training effort ceased five years or more ago. A tremendous handicap on productive capacity has thus been imposed, the effects of which are already being experienced, particularly in the highly specialized mechanical industries.

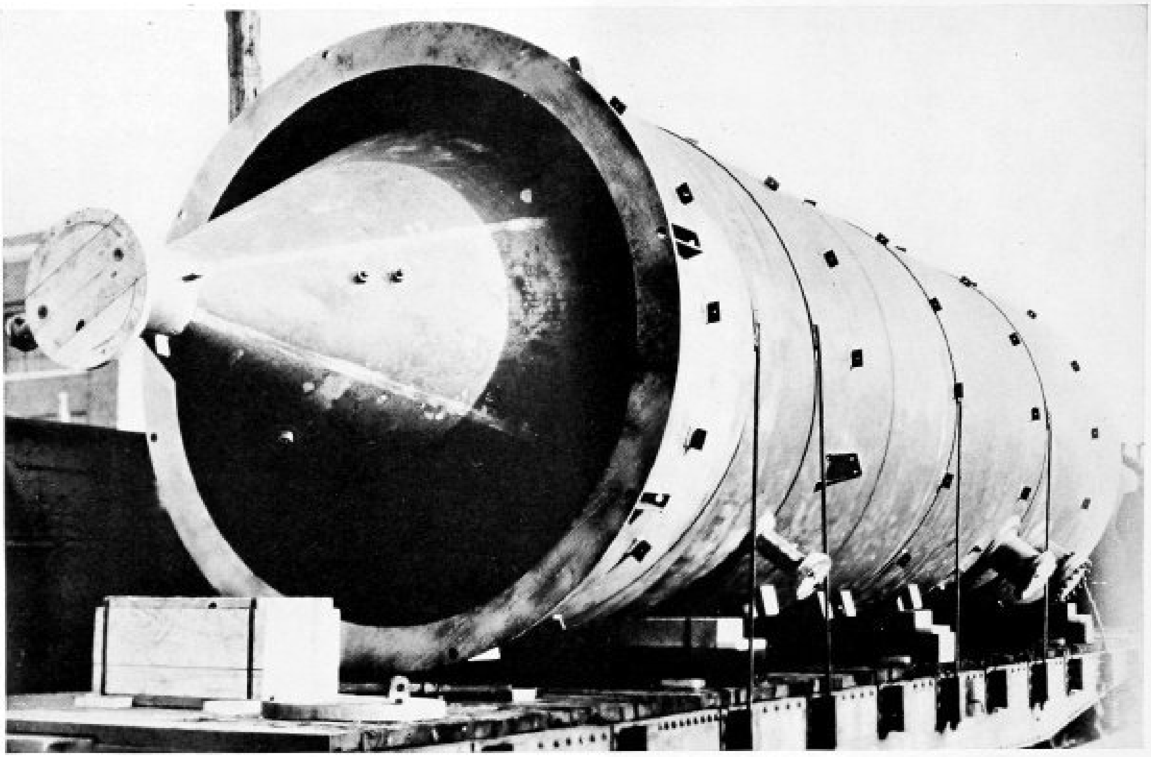
Since properly equipped and staffed apprentice training courses involve considerable expense, it would seem logical that at least a generous portion of the funds recently made available by the Federal government for the "Youth Aid Movement" should be diverted to the education of young men in specific industries, which will offer them opportunities in the skilled trades. By co-operating with industry to this end the government will aid a wide class of individuals for whose benefit the fund is supposed to be administered and industry will be enabled to proceed with the rehabilitation of its man power.

Modern Materials in Relation to Recovery

While the complete proceedings of the tenth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors are not yet available for publication, one of the most important papers presented before this group is featured in this issue. This paper, "Modern Materials for High-Pressure Boilers and Pressure Vessels," is basic since the integrity and strength of any structure depend upon the materials from which it is fabricated. Whether it be for the locomotive boiler, the stationary steam power generator or for pressure vessels, processing vats or storage tanks, modern metallurgical developments which have produced materials of great strength and resistance to corrosion are mainly responsible for the rapid advance in efficiency and long life of these structures.

Progress in the science of metals has been remarkably swift during the years of depression and, as a result, industry faces the future equipped with new and vastly superior instruments of production than ever before. Because of this advance in the technique of material manufacture and in the fabrication of such materials, the decline has been correspondingly more rapid in the productive value of tools and equipment, designed and built with the knowledge of even a decade ago, than would normally occur.

The speeding up of the heavy goods industries is generally held as the key to national recovery. Within all its branches, an ever increasing advantage is being taken of the tremendous possibilities created by the use of modern materials in the replacement of obsolete equipment. So far this movement has been limited more or less to the fabrication of isolated structures, a number of which are mentioned in the paper presented before the National Board. A more general realization of the value of these newer materials will unquestionably result in accelerating the rehabilitation of the plants and equipment of the heavy goods industries.



Welded pressure vessel of nickel alloy steel

Modern Materials for High-Pressure

BOILERS AND PRESSURE VESSELS*

By L. P. McAllister†

Imagine admitting ten to fifteen years ago that boiler plate with tensile strength of 75,000 pounds per square inch was fit for fabrication. Common opinion would have readily labeled such steel as hard, and yet today agreement is almost unanimous that the 55,000 minimum tensile strength steel, equal to specification S-1 of the American Society of Mechanical Engineers Boiler Code, is losing its popularity, particularly in heavy walled shells.

Designers have turned from butt-strapped joints to fusion-welded seams, and with welding came restrictions on material which the process of riveting did not demand. Fabricators realized and welding experimenters discovered that in large sections or heavy plates some lack of uniformity in chemical composition presented problems in obtaining ductile welds. Therefore, at the introduction of the metallic arc, the steel manufacturers found themselves confronted with a demand for more uniform steel to permit acceptable welded joints.

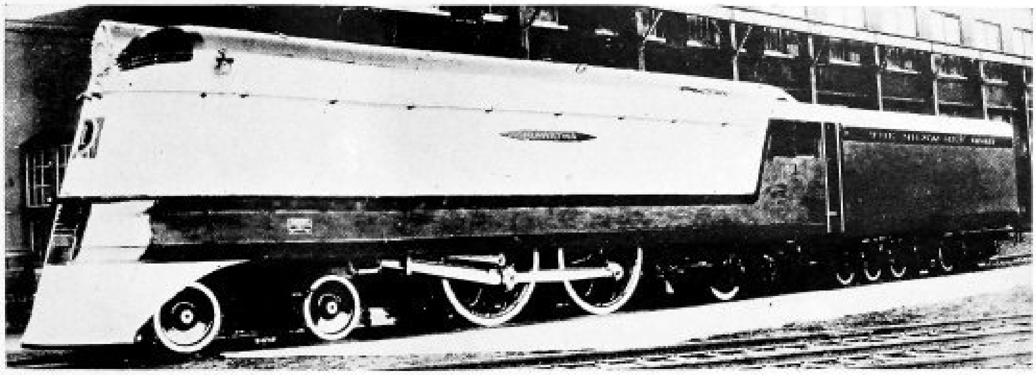
Contemporary, naturally with the demand for a more uniform base metal came extensive experimentation and development in welding technique and procedure. Next the carbon content in the boiler and firebox grades of steel was limited to 0.35 percent maximum. This restriction, although seemingly a natural one from the fabricating group, made it practically necessary that heavy plates be no longer produced of open or rimming steel, and required a killed or deoxidized steel by which process the carbon content could be maintained more uniformly from end to end of large plates, thereby offering to the welder for his seams more homogeneous and uniform edges.

Demands for higher pressures brought the necessity of thicker shells, and to meet or overcome some restrictions of fabrication the Boiler Code adopted two new higher tensile steels, namely, Specification S-26 and Specification S-27, respectively calling for 70,000 pounds per square inch minimum tensile strength for plate material up to and including 2 inches, and over 2 inches up to and including 4 inches. Here was a decided forward step, recognizing the advisability of higher strength material balanced by good ductility and workability. Many

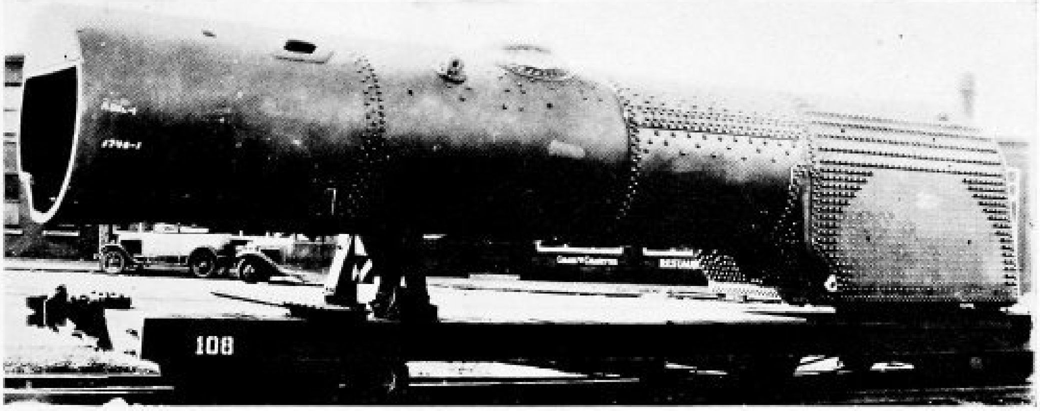
* Paper presented before the tenth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors, Chicago, May 16.

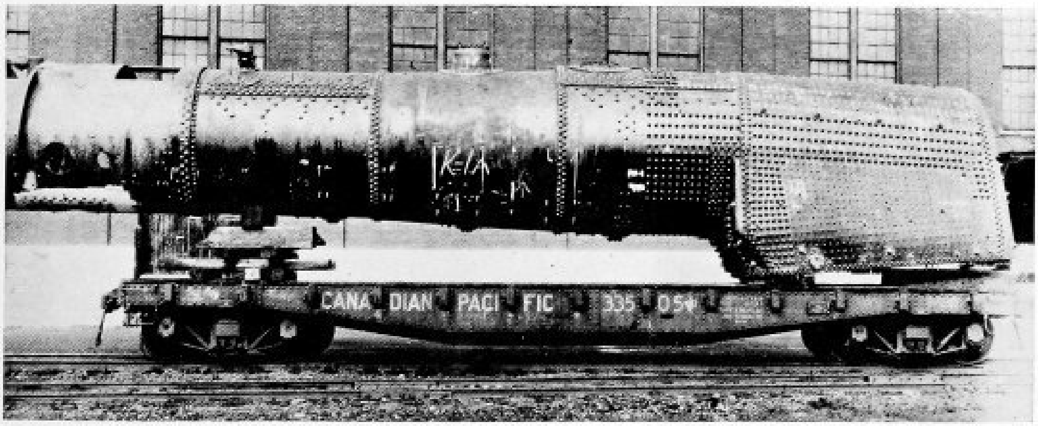
† Assistant metallurgical engineer, Lukens Steel Company, Coatesville, Pa.

The Hiawatha, one of the two new streamlined locomotives for the Milwaukee Road

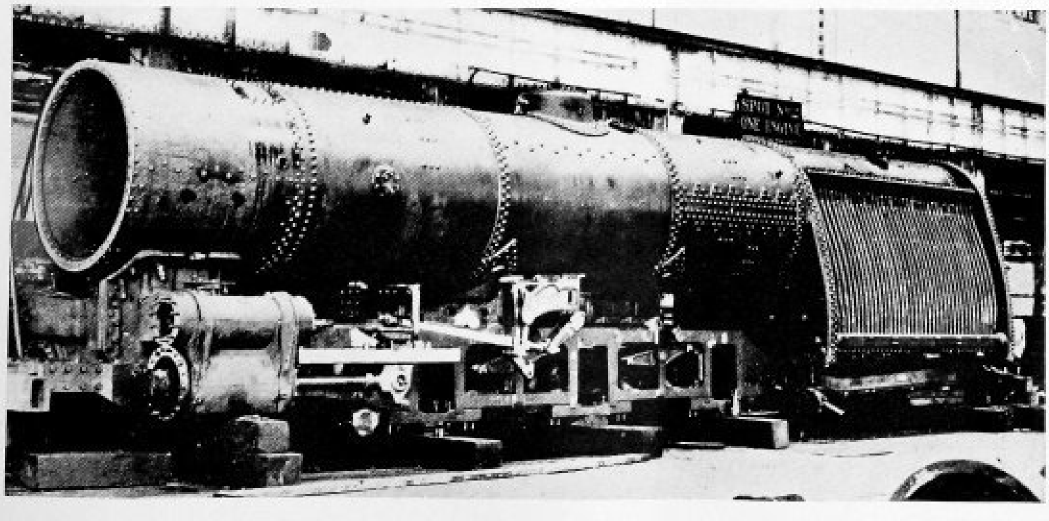


Boiler and firebox of silico-manganesesteel, operating at 300 pounds, for the locomotive Hiawatha

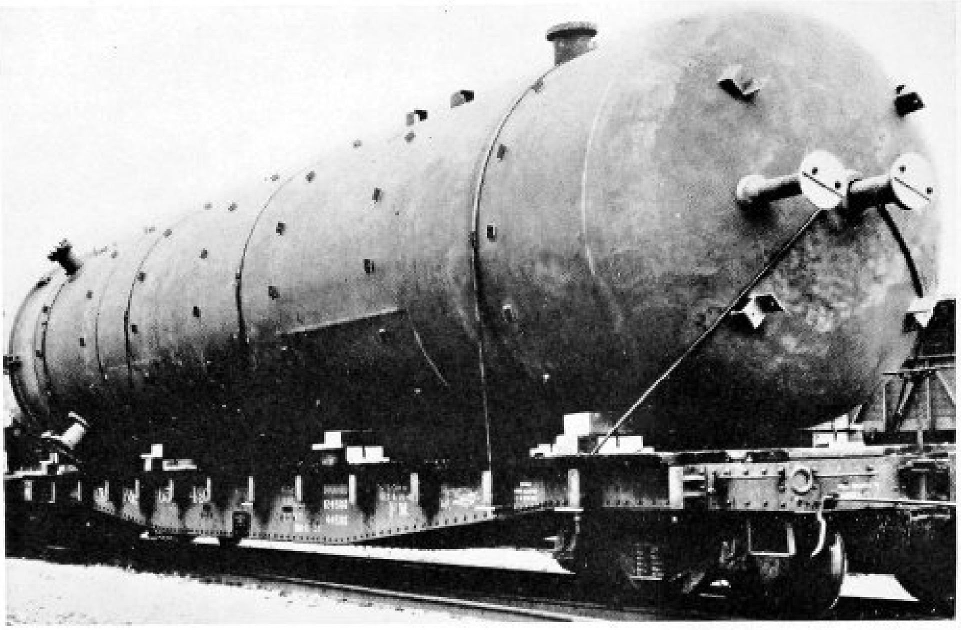




Boiler of nickel-alloy steel for Canadian Pacific 4-8-4 type locomotive built in 1928



This boiler and firebox of nickel alloy steel for a new Baltimore and Ohio locomotive carries 350 pounds per square inch pressure



Pressure vessel used in the oil industry in sub-zero service, built from plates and flanged heads of nickel alloy steel

tons of plates have been rolled, and to match these numerous heads have been flanged of this so-called high tensile grade. Success to date has been rewarded by an increasing demand for this 70,000 pounds per square inch minimum material.

The next step in developing plate material presents a new angle; the welding technicians advise against higher carbon, so to meet the still pressing requests for high strength, alloying elements have to be added to the plain carbon analyses. The properties of plain carbon steel, through long usage, have become fairly well known as have its economic limitations. Now, with the advent of additional and sometimes singular properties inherited from contained alloy, boiler and pressure vessel plate and head material presents a new economic aspect for consideration. When planning alloys for plate material, the first incentive is to produce higher strength without unproportional loss of ductility. High strength in sufficient increments naturally permits a decided decrease in wall thickness and weight, and thereby presents for comparison a saving in purchased weight. The use of alloy steel may perhaps be more economically justified when due consideration is given to such factors as decreased purchased weight, reduced transportation costs on this lighter weight material both in the unfabricated and the fabricated state, possible lower shop costs due to the welding of thinner shell sections, and the metallurgical advantages derived from contained elements. Prevailing fabricating methods and welding technique must be given due regard in new steels. Little, if any, advantage would result from superior quality alloys if fabrication and welding could not be carried out with success.

All designs today of Code construction, either American Society of Mechanical Engineers or American Petroleum Institute, are based on a safety factor of 5 or 4 and working stresses of ordinary steel are used as engineering data. Much work is to be done to prove that higher strength, properly balanced alloy steels can present to the designer permissible stresses above those now set down for plain steel. A joint committee is at work and shortly it is believed that new and higher allowable working stress tables will be adopted, thereby permitting advantage to be taken of the higher physical properties. To be fair and safe, much technical data must be collected and summarized in order that designing engineers, operators and inspecting groups may have confidence in the values.

From judicially mixed or single alloys one should expect some or combinations of several of the following properties above those obtained in ordinary plate stock.

(a) High strength at elevated temperatures.

(b) High impact resistance at upper working temperatures.

(c) Definitely improved creep values.

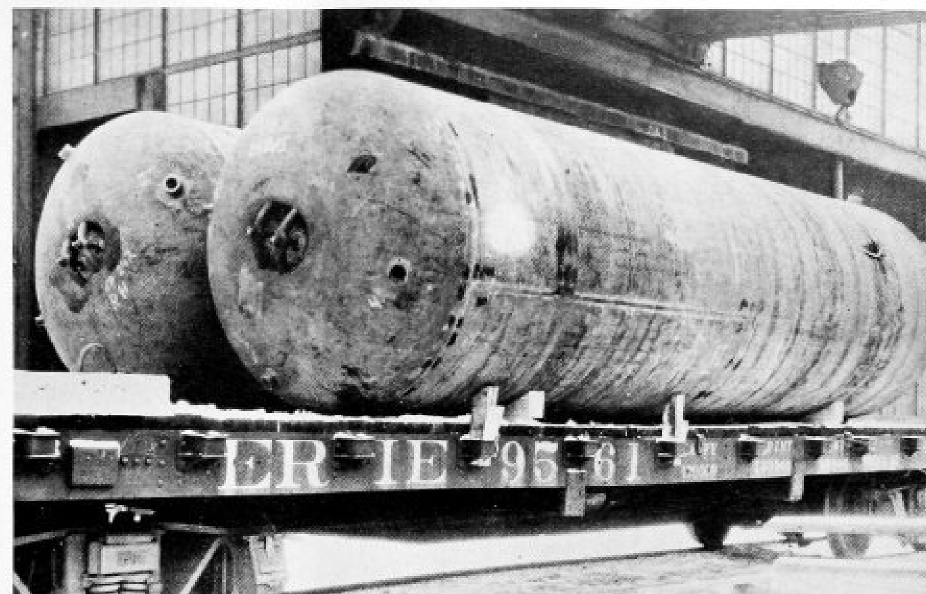
(d) Good sub-zero impact ratings.

(e) Added resistance to some corrosive media.

(f) Better fatigue results.

To what elements now can the steel metallurgist turn for providing some of these improvements in large plate form?

The automotive engineers have had at their command for years many alloy combinations, and tube buyers likewise have had a fairly broad field from which to select. Remembering this fact that the production and fabrication of small parts does not present the hazard that mass does, vessel and boiler material must come from alloy analyses which can be readily produced and constructed. Thermal effect on large and heavy sections has to be dealt with, and consequently today shell and head materials are available in alloy steels which are not so sensitive to the various stages of making and shaping, and, thus the fear of hazardous workability must not be foremost. Note should be made here that for welded construction, the codes have listed among acceptable specifications only plain carbon steel for shell fabrication, and, however significant this fact may be, the day is not far distant when several alloy combinations must become essential parts of material specifications. High strengths are not at their maximum and as the welding art has changed its acceptable standard, so will limits of pressure, temperature and base material; and the next great step will undoubtedly be to base material having a minimum of 100,000 pounds per square inch tensile strength. The demands are present, the methods of production and fabrication are progressing and developing by experimentation, and slowly but safely is being gathered the knowledge needed for achieving this goal.



Fusion welded pressure vessels of nickel-clad steel, fabricated from the largest plates ever rolled from this material

As stated previously, alloying elements for plate construction must not for sensible fabrication exhibit pronounced air hardening characteristics. The application of intricate or even simple heat treatments are not always advisable; quenching and tempering and long time furnace annealing are always accompanied by out of flatness and warpage, making plate fabrication difficult, if not impossible. So, in existing developments steels are being offered which have the improved qualities in the "as rolled" condition. Keeping this problem foremost, the full benefit of all the non-ferrous elements cannot be had. Equipment to some extent limits the production of the more special alloys requiring special treatments, but with the hoped for industrial expansion it is to be expected that progress will not be retarded.

The common alloying elements of nickel, chromium, silicon, molybdenum and vanadium have been used with remarkable success. By use of small percentages, steel makers have been able to produce some of the qualities which should be expected from a higher base price material. One of the chief outstanding metallurgical advantages of the use of the elements mentioned is the maintaining of high strength by substituting one or more of these elements for increased percentages of carbon. Thus, with the so-called low alloy content steel, carbons need not exceed or even reach the limit of maximum 0.25 percent, as used in a 55,000 pounds per square inch tensile strength steel, to produce tensile values over 50 percent higher than this figure. This advantage undoubtedly is attractive to the welding engineer.

Unfortunately there has existed in the minds of some users a suspicion or feeling of mystery about alloys. The metallurgical benefits from contained elements need only some understanding to alleviate such suspicion. Some regard for the properties imparted may slightly change fabricating methods, but not to such a degree that any ordinarily well equipped Class 1 welder need fear his ability to construct. Nickel, chromium, silicon, etc., are used to improve the steel, not to make it more mysterious. Stiffness of alloy material is to be expected, but so long as brittleness does not accompany the higher strength, the resulting toughness is an advantage. All tonnage to date has been preceded by experimental work and it would not be amiss to discuss a few of the rather recently used alloy materials which have proved themselves worthy of the confidence intrusted to them.

Two percent nickel steel with carbon under 0.20 percent, pioneered by a Canadian Railway in a large locomotive construction program, has served so well that many railroads have installed wrapper sheets of this analysis. The tensile strength of 75,000 pounds per square inch permitted a decrease in shell section, and although subject to the stress of locomotive service, the excellent ductility (see Table I) of this type has proved its merit. Even inside firebox sheets with an ultimate of 65,000 pounds per square inch have been installed, and longer life of side sheets with minimized crowfeet checking around staybolts has been noted.

TABLE I.—CHEMICAL AND PHYSICAL PROPERTIES OF 2 PERCENT NICKEL STEEL PLATES

Analysis				Thickness, inches	Yield Point lbs./sq.in.	Tensile Strength lbs./sq.in.	Elongation percent in 8 inches
C	Mn	Si	Ni				
.13	.52	.20	2.10	½	52,500	76,000	28.00
.16	.56	.21	2.25	¾	44,000	75,000	28.50
.16	.57	.25	2.08	⅞	47,000	75,600	26.00
.17	.66	.23	2.23	1	49,300	82,000	26.25
.16	.56	.21	2.25	1	46,600	75,500	29.00
.18	.68	.19	2.90	2	47,800	79,000	23.70

This same analysis has found an opposite, although very important, use in sub-zero service. Here the added nickel definitely increases and makes uniform impact values even at temperatures as low as —100 degrees F. Consistently, Charpy impacts of 15 foot pounds at —75 degrees F. can be obtained, (see Table II). So too the dewaxing process of the refining industry is offered by this alloy a metal whose resistance to shock at low working temperatures is far better than any plain carbon steel, as shown by results consistently obtained to date.

TABLE II.—TWO PERCENT NICKEL STEEL PLATE. CHARPY IMPACTS (FOOT POUNDS)

Analysis				Thickness, inches	—50 degrees F.	—75 degrees F.	Condition of steel tested
C	Mn	Si	Ni				
.16	.62	.18	2.22	½	31—33—35	17—22—23	As rolled
.15	.49	.19	2.03	⅝	31—29—34	19—21—22	" "
.16	.48	.19	2.10	9/16	39—39—39	32—32—30	" "
.18	.54	.19	2.10	15/16	35—38—36	20—24—20	" "
.18	.66	.24	2.24	1⅛	32—35—35	18—22—20	" "

The United States Navy for its high tensile steel; i.e., 80,000 pounds per square inch minimum tensile strength, found it advisable to list in its hull steel specification a manganese-vanadium grade of the following typical analysis: Carbon under 0.18 percent, manganese maximum 1.45 percent and vanadium 0.08 percent to 0.18 percent. Numerous tests carried out at Washington indicated to the Bureau of Construction and Repair that this analysis exhibited less tendency to air harden in the welded zone than some other steels so tested. Ship welding varies definitely from pressure vessel welding in that stress relieving or heat treatment after welding is impossible. Consider now this analysis and its possibilities—a particularly high ratio between yield point and tensile strength (see Table III). If advantage for code designing could take into its formulae the yield point as a basis of determining allowable working stress, this steel would present a big advantage in weight saving.

TABLE III.—CHEMICAL AND PHYSICAL PROPERTIES OF MANGANESE-VANADIUM STEEL PLATES

Analysis				Thickness, inches	Yield Point lb./sq.in.	Tensile Strength lb./sq.in.	Elongation percent in 8 inches
C	Mn	Si	V				
.15	1.40	.20	.13	½	59,800	87,200	24.00
.15	1.40	.20	.13	½	63,600	92,600	20.00
.16	1.43	.22	.10	½	65,000	89,600	22.75
.16	1.43	.22	.10	⅝	61,700	93,600	20.00
.15	1.40	.20	.13	⅞	62,600	92,000	24.25
.16	1.43	.22	.10	¾	64,600	92,000	23.50

Due attention is just beginning to center around carbon-molybdenum plate steel. By this is meant carbon under 0.25 percent and molybdenum between 0.40-0.60 percent. Tubes of this grade have been successfully used and the plate industry is now arousing to the advantage that molybdenum gives; i.e., definitely improved physical properties at elevated temperatures. One has only to scan the creep values of carbon-molybdenum steel and compare them with values on steels of equivalent room temperature strength, and readily the imparted improvements can be noted. Advantage has been taken of this element in Europe for years. In plate and vessel material, room temperature strength of 75,000 pounds per square inch can be easily obtained. Units of this grade are in service in an eastern refinery, and the latest information indicates complete realization of anticipated results.

Mention was made previously that the American Society of Mechanical Engineers Boiler Code had not adopted any alloy grade for welded construction. This is true, but one alloy specification, namely S-28, has been approved for riveted construction. Such rapid and satisfactory progress has been made with this C.M.S. steel that obviously early recognition for welded vessels is looked for. This C.M.S. specification, as listed in trade name, represents an alloy called Cromansil. Such steel is made and listed in two grades; i. e., minimum 75,000 pounds per square inch and minimum 85,000 pounds per square inch tensile strength. The carbon content in the first grade is limited to 0.17 percent maximum, while the 85,000 pounds per square inch minimum class permits a 0.25 percent maximum carbon. The name of this popular low alloy—Cromansil—reveals its chief components; i. e., chromium, manganese and silicon. Each of these elements is found in the following ranges: Chromium 0.30 to 0.60 percent, manganese 1.05 to 1.40 percent, and silicon 0.60 to 0.90 percent. The metallurgical balance of these three toughening elements has made possible a very versatile and workable low alloy steel of good high strength properties without the decided loss of that very necessary factor called ductility (see Table IV).

TABLE IV.—CHEMICAL AND PHYSICAL PROPERTIES OF CROMANSIL STEEL PLATES

Analysis						Thickness, inches	Yield Point lbs./sq.in.	Tensile Strength lbs./sq.in.	Elongation percent in 8 inches
C	Mn	P	S	Si	Cr				
.12	1.12	.030	.017	.55	.54	¼	60,000	80,400	25.00
.12	1.12	.030	.017	.55	.54	¾	47,100	76,300	27.00
.14	1.26	.035	.022	.77	.47	1	55,600	80,200	26.50
.21	1.17	.014	.024	.72	.47	2	53,200	85,600	20.00
.14	1.24	.010	.018	.76	.47	3	45,600	77,400	21.25
.20	1.28	.027	.018	.73	.52	1½	54,000	88,200	22.75

The merits of any material are best substantiated by its use, and actual tests are worth many expert opinions. The many tons of this steel which have been most successfully welded into Diesel engine frames and housings of various intricate shapes and thicknesses, and the complete power units developing around 600 horsepower at 1200 revolutions per minute with the accompanying vibratory stresses prove beyond a doubt that this alloy has weldability and toughness which warrant much added consideration. Taking advantage alone of the high strength of the 85,000 pounds per square inch minimum grade, reductions in weight are so evident that its attractiveness cannot be denied.

Nickel and chrome-clad materials have been produced whose corrosive resistant properties present to users very definite economic savings. The strength of plain steel base material can be used for computing working stress and the thin layer of cladding, securely bonded, can be depended upon to resist the corrosion for which it is recommended. Ten and 20 percent nickel-clad plates have been successfully produced and fabricated and fusion welded to Class 1 requirements of the American Society of Mechanical Engineers Boiler Code. Vessels so constructed meet, particularly in the chemical industries, a long sought for need. The manufacturing methods of this nickel-clad material have been so developed that uniform thickness of the cladding is assured, and the bond between the layer of nickel and the base steel is a metallurgical one. The good physical properties of the base metal are not impaired by this bonded layer of nickel since this element alone is strong and ductile. Satisfactory welded joints can be made by using ordinary steel rods on the base metal side, and pure nickel rods on the clad side, thereby making a continuous lining of pure nickel.

Other combinations of alloys worthy of consideration are being offered and developed for various purposes. The appreciation of improved quality is foremost today, and one of the very necessary aids for this development is the addition of wisely selected alloys. Due regard must be given, first of all, to well and carefully made steel, for just the addition of certain metals will not overcome poor melting practice. Extra care and close observation with technical control are most essential today in order to offer for fabrication and construction better and higher quality steel. The selection of base material of the proper quality must be given thought and the industry today more seriously than ever before, is, so to speak, use-minded. Consequently the opinions of fabricators and inspection groups are welcomed and encouraged in order to guide the development of either plain carbon or alloy steel since the day of special steels for almost individual purposes is here to stay.

Buffalo Office of Republic Moved

The Buffalo, N. Y., district sales office of Republic Steel Corporation has been moved from 475 Abbott Road to 1020 Liberty Bank Building, according to an announcement by N. J. Clarke, Republic's vice-president in charge of sales. Thos. B. Davies continues in charge of the office as district sales manager, assisted by his present staff.

Methods of rolling-in

BOILER TUBES*

By F. F. Fisher[1] and E. T. Cope[2]

This paper presents an introductory study of boiler-tube rolling and reviews the methods now in common use. It points out their limitations and explains and proposes specifications for a new method which approximates the ideal. Test results are given which show the superiority of this new method. A few pertinent details of tube rolling are also mentioned, including the over-rolling of tubes as a source of high stress concentration in the sheet metal around the tubes. This stress concentration may be a source of corrosion fatigue

Although much has been written about boiler shells and tubes, and riveted and welded joints, apparently nothing has been published in English about the method of fastening tubes into boiler shells and tube sheets. It is true that test methods have been applied for determining the watertightness of these joints, but such tests do not disclose the condition of the joint. Manufacturers of rolling tools furnish instruction booklets briefly explaining the use of the tools, yet engineering publications printed in English contain no information regarding this very important item of boiler design and construction. Although all other parts of the boiler are designed with great care by engineers after careful study of strength of metals, effects of temperature, the permissible oxygen and carbon-dioxide content of boiler feed water, etc., the production of the joints between the tube ends and the tube sheets or drums has been left largely to the ingenuity of the mechanics who assembled the structure. It appears, therefore, that the expanded tube joint, if its use is to be continued, should be subjected to scientific study, its limitations recognized, and an effort made along scientific lines to standardize field practice so that all the joints in a given boiler may be of maximum strength as determined by such investigation.

The knowledge of what constitutes a satisfactory rolled joint is now lacking. Once this knowledge is available and the correct procedure for rolling the joint has been established, the production of joints of maximum strength and tightness could be controlled. If the tubes could be machined to fit into carefully tooled tube holes, or if the tube ends could be shrink-fitted into the holes, the problem would be relatively easy. But liberal clearances must be allowed to permit easy introduction of the tubes into the holes, particularly in tight places, of which there are many in a modern large-capacity boiler. Commercial practice and the demand for low-cost production puts precise machining out of the question.

On the other hand, if the differences in diameters between the tubes and tube holes were constant to a micrometer tolerance and the tube-wall thickness did not vary, the problem of securing uniform joints would be relatively simple. Also, if the surfaces of tube and tube hole which are to produce the joint were of uniform and standard finish, the production of uniformly tight and strong joints would not be so difficult. But when joints are to be made between the surfaces of tube ends and tube holes in which the clearance may have any value from ten-thousandths to sixty-thousandths of an inch in a bank of tubes, where the tube holes are reamed to commercial finish yet the tubes are covered with mill scale or are indifferently cleaned, one should not be surprised if a considerable percentage of the joints shows leaks when the assembled structure is subjected to a hydrostatic pressure test. Neither should one be surprised if the re-rolling operation causes leaks in joints accepted on the first hydrostatic test, nor that such joints fail after a comparatively short period of service.

The production of a joint by expanding a tube into a tube hole entails the execution of two distinct phases of the rolling-in operation. The first consists of stretching the tube wall until there is contact between the outside surface of the tube and the inside surface of the tube hole. A joint does not begin to exist until this contact has occurred. As already noted, the difference in diameter of the tube and the tube hole is by no means constant in any group of prospective joints. Therefore, the amount of expanding of the tube necessary to produce contact between tube wall and tube hole may vary widely from tube to tube. Consequently, this fact must be taken into account when producing a joint.

The second phase of the rolling-in operation consists of giving the tube wall further permanent stretch, thus pressing the outside surface of the tube against the inside surface of the tube hole. This pressure alone is the source of fluid tightness in the joint. Also this pressure, coupled with the friction between the two metal surfaces, is the source of the strength of the joint which holds the tube in the tube hole when pressure is applied within the boiler. Since the pressure between the two surfaces is the only variable in any given case entirely within the control of the mechanic doing the assembling, it might be at once concluded that the greater the expansion the better the joint. That this is not true has been demonstrated by tests which show that both the tube wall and the metal surrounding the tube hole are subjected to severe cold working when excessive expansion is prac-

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tised. When a tube must be replaced in a tube hole which has been heavily over-expanded, the hole is badly distorted and should be re-reamed to true it up and to remove the metal which was overstressed at the previous rolling.

The formation of an ideal joint by rolling-in requires:

1.—A device for expanding the tube so that it is cylindrical at all times during the rolling-in operation.

2.—A means by which the completion of the first phase of the rolling-in will be indicated definitely. This anticipates a mechanical, a magnetic, or an electrical device for positively indicating the establishment of a firm contact between the outside surface of the tube and the inside surface of the tube hole.

3.—A means for indicating the amount of deformation of the metal surrounding the tube hole. This metal should not be stressed beyond its elastic limit.

A method of tube expanding based on these requirements should produce fluid-tight joints which show the optimum strength to resist destruction when subjected to fluid pressure. Furthermore, it has been well established that corrosion fatigue occurs at points of high stress concentration. The metal of tubes and tube sheet surrounding the holes in boilers in which the tubes have been heavily over-rolled should be an ideal point for the beginning of this form of failure.

This paper presents the results of a study of the expanding of boiler tubes and proposes a method which, over a five-year period, has produced uniform joints of optimum strength. In this method the severe cold working of the tube and drum metal, because of excessive expanding of the tubes, has been either avoided entirely or reduced to a minimum.

Conventional Methods of Tube Expanding

Three methods of tube expanding are generally accepted. These are the tube-bulge method, the uniform-expander-entrance method, and the measured-energy-input method. These will be reviewed briefly and their limitations pointed out. In the tube-bulge method, a few tubes in a bank, used as samples, are expanded until their outside diameters are increased a definite amount ($\frac{1}{32}$ inch usually) over the nominal tube-hole diameter. This measurement is made immediately next to the tube sheet or drum on the gas side in a water-tube boiler and the water side in a firetube boiler. The amount of tube bulge is measured by a gage of fixed opening. The expanding or rolling operation is carried out until this outside gage fits the bulge of the tube. After the operator gets the "feel" of rolling-in these samples, he proceeds to roll-in the remainder without measurement.

In the second method of tube expanding, the tool is entered a fixed distance into all the tubes in a given bank. This distance is determined by trial on a few tubes and the stop is set. In the uniform-energy-input method all joints are rolled-in with a consumption of a given amount of energy expressed in watt hours or horse-power hours.

In these methods of tube expansion there is no way of knowing definitely when the tube surface contacts the tube hole. Also, there is no way of knowing how much the tube is expanded after contact occurs.

Table 1.—Measurements of Five Groups of Tubes and Tube Holes

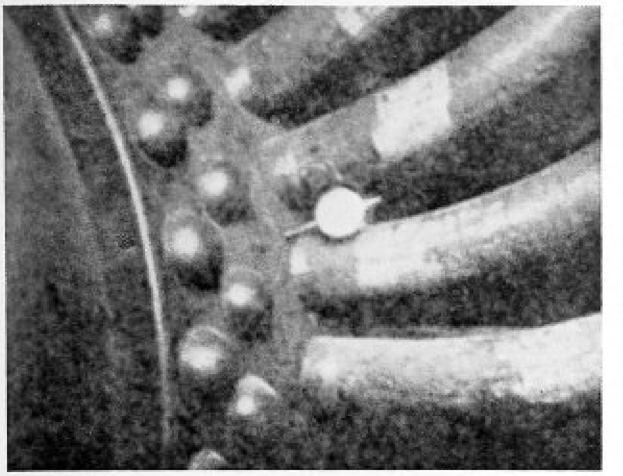
Nominal tube size, in.	2	2	3¼	4	4
Minimum outside tube diam., in.	1.981	1.994	3.236	4.002	3.987
Maximum outside tube diam., in.	1.991	2.004	3.285	4.013	4.008
Minimum wall thickness, in.	0.186	0.138	0.189	0.204	0.211
Maximum wall thickness, in.	0.213	0.143	0.211	0.256	0.262
Nominal tube-hole diam., in.	2.031	2.031	3.281	4.031	4.031
Minimum tube-hole diam., in.	2.025	2.030	3.267	4.020	4.025
Maximum tube-hole diam., in.	2.040	2.038	3.320	4.041	4.039

Measurements made on five groups of tubes and tube holes revealed the values given in Table 1. The customary allowance of $\frac{1}{32}$ inch for tube bulge would result in a wide variation in the actual amount of expansion in the cases of the minimum and maximum sizes of the tube holes shown. The holes of minimum diameter might be over-expanded. The tube-bulge method of expansion, therefore, does not meet the second and third requirements of the ideal expansion method. If, on the other hand, these joints had been assembled by the uniform-expander-entrance method, in which no exact account is taken of the variation in clearance between tube and hole, and no allowance is made for the variation in tube-wall thickness, it is obvious that the resulting joints would not have been expanded uniformly. If by chance, resulting from random choice of tubes, the smallest tube having the thinnest wall had been expanded into the largest hole, the resulting joint would have been very different from the one resulting from expanding the largest tube having the thickest wall into the smallest hole. In the first case the tube might have been expanded only enough to contact the tube hole, whereas in the second case the joint would have been heavily over-expanded, resulting in severe cold working of the metal of tubes and tube sheet and the setting up of points of very high stress concentration. This second method also falls short of meeting the requirements of the ideal method of tube expanding.

In the uniform-energy-input method no account is taken of the influence of differences in tensile strength of the metal of the tubes and sheets, differences in clearance between tube and tube hole, nor the condition of the rolling tool. When the self-feeding expander is used, the power required to flare the tube is at maximum at the same instant as that required for completing the rolling-in operation of the joint itself. The flare does not constitute an essential portion of the joint, as will be shown later, and the energy required to complete the flare cannot be separated from the total. This method also falls far short of meeting the requirements of the ideal joint.

The shape of the entering ends of the expanding-tool rollers is a matter of considerable importance. Since the metal on the inside of the tube wall is cold worked, it is of the highest importance that this cold working should take place with the least possible disturbance of the metal surface. If the entering ends of the rolls are not sufficiently rounded, they leave a sharp shoulder at the inner end of the rolled portion. This produces an ideal starting point for cracks or corrosion, as shown by numerous tube failures which have been investigated. With self-feeding expanders, especially when used for rolling-in tubes into thick sheets (such as 1¼ inches and upward), the metal on the inside of the tube is plowed up by one roller and then rolled down by the succeeding ones. This leaves a spiral mark on the inside of the tube. It is usually not noticeable upon casual inspection, yet constitutes an excellent starting point for corrosion. To correct this condition the boiler erectors in the authors' company have ground the entering ends of the rollers of their expanders to a 5-inch radius. A certain amount of cold working takes place, but instead of the metal being plowed into a sharp crest it is moved ahead of the rollers in the form of a gentle undulation. No roller scars are visible on the inside surface of the tubes.

The elongation method of tube rolling, as developed by the company with which the authors are associated, more nearly fills the specifications for an ideal method than does any one of the other methods noted. In this method advantage is taken of the fact that the tube is loose in the tube hole until the first phase of the rolling-



Dial indicator attached to a tube

in is completed. It further takes advantage of the fact that during the expanding operation the wall of the tube within the tube sheet is thinned. The metal is squeezed between the expanding tool and the surface of the tube hole and is forced to flow axially. This moves the tube axially a measurable amount, which is a function of the degree of the expansion. The only extra tool required by this method is a dial indicator fitted with the proper size clamp, so that the indicator may be readily attached to the tubes. The tube is inserted into its tube hole and manually held in place. The dial indicator is attached as shown in the illustration. The clamp extends half way around the tube and bears at three points to prevent rocking. The end of the shaft of the dial indicator rests on the tube sheet or drum. The expanding operation proceeds, using a "parallel" expanding tool. During the first phase the needle of the dial indicator vibrates until the tube has been stretched into circumferential contact with the tube hole. At the instant of this contact the needle comes to rest, indicating that the first phase has been completed, and item two of the ideal method of expanding has been met. Continued expansion further stretches the tube wall into firmer contact with the hole and squeezes it so that axial flow occurs. This axial flow causes movement of the dial-indicator needle. The amount of movement of the needle necessary to produce the best joint has been established by tests which will be described later.

Table 2.—Dimensions and Change in Dimensions of Four Tubes Subjected to Different Degrees of Rolling*

Before expanding			After expanding			
Outside diam.	Inside diam.	Wall thickness	Outside diam.	Inside diam.	Wall thickness	Elongation
3.996	3.580	0.208	4.010	3.608	0.201	0.010
3.990	3.578	0.206	4.031	3.630	0.196	0.020
4.008	3.586	0.211	4.036	3.642	0.197	0.030
3.995	3.575	0.210	4.031	3.645	0.193	0.040

* All dimensions in inches.

The dimensions and change in dimensions of four tubes of a given size, with different degrees of rolling, are given in Table 2. The tube dimensions were taken during a test conducted in connection with the elongation method of tube expanding. These tubes were cleaned, using a mechanical tube-end cleaner having carborundum cutters of 120-grit grade *H*. In place of a regular tube sheet, blocks of boiler plate 10 inches square, 2¼ inches thick, and with one reamed tube hole each, were used. Three tubes were expanded to each of several elongations (axial movement caused by the rolling-in operation), all without flare. Each tube assembly was then subjected to hydrostatic pressure until the joint broke and the tube was forced out of the hole. Measurements of the tube diameters and wall thickness were made before expanding and after the assembled tube and block had been separated.

Table 3.—Changes in Dimensions During Expanding Operation of the Four Tubes Listed in Table 2

Elongation, in.	Outside diam. increase, in.	Inside diam. increase, in.	Wall thickness decrease, in.
0.010	0.014	0.028	0.007
0.020	0.041	0.052	0.010
0.030	0.028	0.056	0.014
0.040	0.036	0.070	0.017

Table 4.—Assemblies of Tubes and Tube Sheets for Which Holding Strength Has Been Determined

Nominal outside diam., in.	Nominal wall thickness, gage	Plate thickness, in.
2	8	1.25
2	11	1.25
3¼	7	2.25
3¼	7	1.00
3¼	11	1.00
4	5	1.25
4	7	2.25
4	7	1.00

During the expanding operation, the changes given in Table 3 occurred. Even though the changes in outside and inside diameter of the tube rolled to 0.020-inch elongation were not consistent with the others in the schedule, the decrease in wall thickness and the axial movement were consistent.

It is evident from Table 3 that the elongation of the tube and the decrease in wall thickness are related. It remained only to establish experimentally the values of the relationship in terms of strength and water-tightness of the joints produced. The experimental determination of the relationship between elongation and the strength of the joint to resist destruction by hydrostatic pressure, called "holding strength," has been found for the assemblies of tubes and tube sheets listed in Table 4.

The tubes in several boilers have been expanded using the elongation method and the results have been highly satisfactory. Among these are the following:

1.—Boiler No. 14, Trenton Channel power plant, operating at 400 pounds per square inch. There were no leaks, but only small beads of water appeared on some joints. A light re-expanding of the joints on one drum was carried out and the boiler was passed.

2.—Two boilers at the Ford Motor Company, Dearborn, Mich., operating at 1425 pounds per square inch. The erector expanded the tubes in the same manner as were those at the Trenton Channel power plant. The tubes on the first boiler were expanded to 0.020-inch elongation. It was found necessary to re-expand a small portion of the tubes in order to pass the hydrostatic test. In the second boiler, the tubes were all expanded to 0.025-inch elongation, and were passed on the first inspection without exception.

3.—Two boilers at the Springwells Plant of the Detroit Board of Water Commissioners operating at 400 pounds per square inch. Elongation failed to show on the first few tubes expanded. An investigation disclosed the fact that some of the tube holes were tapered. This condition was corrected and the tubes were then expanded to 0.016-inch elongation. The hydrostatic test showed 25 slight leaks among 532 tubes (1064 joints). These were corrected by light re-expanding. By either of the conventional methods this condition of tapered holes would probably not have been discovered and serious trouble might have developed.

There are several other related matters in the expansion of boiler tubes which should be given consideration. These are discussed briefly as follows:

1.—*Effect of the Condition of Finish of Surfaces of Tube and Tube Hole on Tightness and Holding Strength.* When joints of any group are rolled-in to uniform elongation, the tightness and holding strength will depend largely on the finish of the surfaces which are forced into contact. It is obvious that a threaded joint between tube and sheet would produce a holding strength equal to the tensile strength of the net area at the root of the thread. This may be regarded as the strongest type of mechanically assembled joint. The minimum value of holding strength might be developed if the surfaces were polished. Logically, the holding strength of a joint in which the tube surfaces had been cleaned, using a mechanical tube cleaner equipped with carborundum cutters of 120-grit grade *H*, would fall between the maximum and minimum values suggested above. The strength of the threaded joint can be calculated if the form of the thread is known.

The holding strengths of the joints in which the surface of the tubes had been polished and those in which the tube surface had been cleaned using a mechanical tube cleaner, were determined by hydrostatic test. In both cases the tube holes were smooth bored. The outside diameter of the tube was 3.996 inches, the inside diameter was 3.580 inches, it had a hardness of 70 Rockwell *B* (124 Brinell), and an approximate tensile strength of 60,000 pounds per square inch. Tests on joints showed an average holding strength to be 2033 pounds per square inch for the one having polished tube ends and a holding strength of 3700 pounds per square inch for those joints in which the tube ends were cleaned by a mechanical tube cleaner. The calculated strength of a threaded joint (25 threads per inch) between this size tube and a tube sheet 2¼ inches thick is 118,800 pounds. The total strength of the polished-tube joint was 27,600 pounds, and that of the tube of standard finish used in the authors' company was 46,500 pounds. It is probable that a machined tube rolled into a roughened hole would show the same holding strength as the roughened tube rolled into a machine-finished tube hole. It is evident from these figures that the condition of the two surfaces is a factor of first importance in the production of joints of high holding strength. It must be concluded that attention to the cleaning of tube ends is an important factor in the production of joints of uniform strength.

2.—*The Effect of Hardness of Tube and Sheet Metal on Strength and Tightness of Joints.* Enough data have not been collected to warrant any conclusions in this matter. It merits some study and research.

3.—*The Effect of Grooves in the Tube Hole.* Grooved tube holes have been used in an effort to improve the tightness and holding strength of rolled-tube joints. There are, however, few test data available to show the amount of improvement resulting from this expedient.

4.—*The Function of the Bulge and Flare.* The opinion is held by boiler men that the tightness and strength of the joint depend in part on the bulge and the flare made during the expanding operation. It is true that the flare will prevent the tube from slipping out of the tube hole. When the tube is rolled-in, the backing out of the expander pushes the flare a few thousandths of an inch away from the tube sheet so that the flare does not contribute to the tightness or holding strength of the joint. Also, in many cases the flare is not correctly rolled and its effect on holding strength is therefore doubtful. In the case of flat tube sheets, the initial expanding of both bulge and flare will produce contact completely around the tube. On the other hand, in joints expanded into curved tube sheets excessive work on the flare is necessary to produce contact all around the tube. This produces a rounded edge in the tube hole which makes very difficult the refitting of a new tube in case of replacement. The flare does perform an important function in providing a smooth entrance to the tube which reduces the resistance to flow.

5.—*Effect of Lengthening the Tubes Caused by Rolling-in.* The tests which established the elongation method of rolling-in tubes, showed that the tube is lengthened a measurable amount by the rolling operation. The more heavily the tube joint is rolled-in, the greater the lengthening of the tube. If adjacent tubes in a drum or tube sheet are rolled-in to different elongations, the difference in lengthening sets up considerable thrust on the tube which has been rolled the least, or compression on the tube which has been rolled the most. This compression may lead to the bowing of the more heavily rolled-in tube with the possibility of failure because of interference. If it were possible to roll-in all the tubes of a given bank or bundle simultaneously and equally, there would be no difference in lengthening of adjacent tubes. But at present tubes are rolled-in one at a time. The elongation given each tube except the first, imposes a thrust on all tubes that have been previously rolled-in.

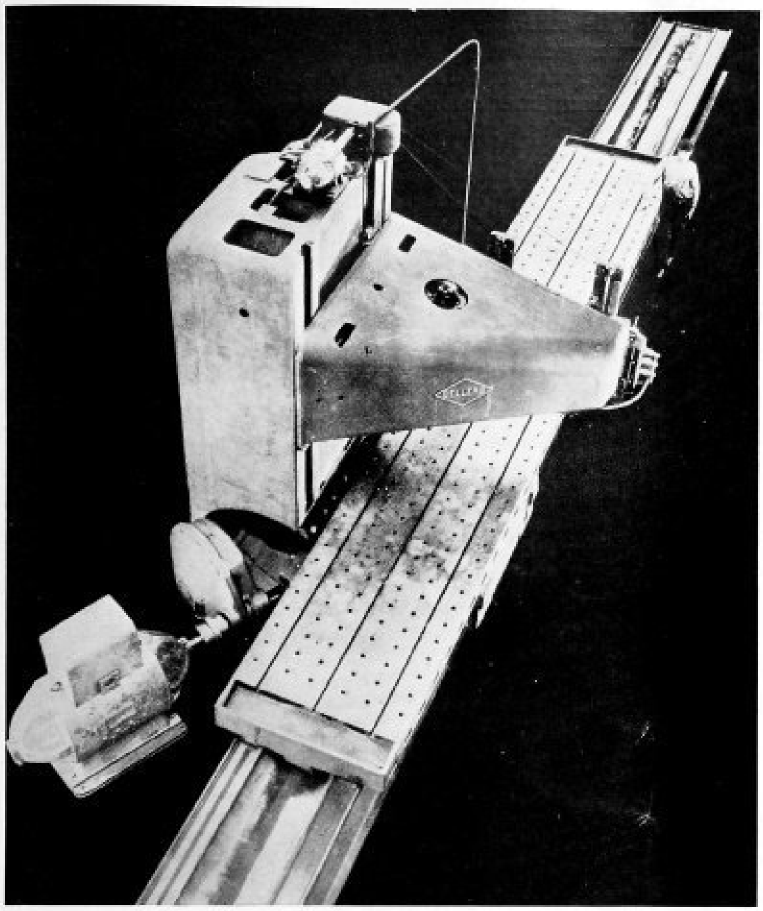
The presence of accumulation of thrust is especially evident in straight "tack tubes." That this is true is shown by the failure of tack-tube joints during assembling of the boiler, and perhaps more frequent failure after the boiler has been in service for some time. The actual value of this axial loading is a difficult matter to calculate, because of the shapes and arrangements of the tubes in any given boiler. An approximation has been made, however, by actually weighing the axial thrust during the rolling-in operation.

This was carried out by having the free end of a short tube, which was being rolled into a 10-inch square plate, exert its axial thrust against the ram on a hydraulic jack. The base of the jack and the plate were rigidly joined together. The hydrostatic pressure shown by the gage on the jack was multiplied by the area of the jack plunger to give the value of the thrust. While this test is not presumed to reproduce the conditions occurring during the erection of a boiler, yet it does indicate the possible magnitude of the thrust.

The accumulation of thrust, if not controlled, often results in the bulging of the tube sheets, the raising of steam drums off their supports during erection or even the rupture of tubes. Control of cumulative thrust applied to boilers having drums may be effected by either of two procedures. In both cases tack tubes are installed first. They are fully rolled-in at one end and partly rolled-in at the other. Next, the remaining tubes are fully rolled-in at one (usually the upper) end and partly rolled in (usually to 0.005-inch elongation) at the other end. In the first procedure, the partly rolled-in ends are then fully rolled-in proceeding along the length of the drum. In the second procedure, tack tubes are rolled-in as in the first procedure. All remaining tubes are fully rolled-in at one end (usually the upper end), the remaining joints are then rolled-in, starting at the middle of the length of the bank and rolling tubes to full elongation toward the ends of the bank. This divides the amount of accumulated elongation and the consequent thrust in half. In long banks, the rolling-in of the remaining tubes is carried out by dividing the length of the bank into four parts and rolling the tubes in each fourth of the length separately. Any of these methods reduces the amount of accumulated thrust and makes less likely the failure of the joints from this cause.

A few tests were made to determine the characteristics of the expanding tool. These tests were conducted by rolling-in 3¼-inch, 7-gage tubes into 2$\frac{3}{16}$-inch plate. The feed angle was changed for the different tests and a

(Continued on page 188)



Advanced design of openside planer

OPENSIDE PLANER

An entirely new and advanced design for openside planers 60 inches and larger has recently been developed by Wm. Sellers & Company, Inc., Philadelphia. Many novel and interesting features have been worked out to simplify the operation and improve the performance of the machine.

The illustrations show a 60-inch by 60-inch by 30-foot machine installed in the manufacturers' shop. It may be noticed that the design is unusually clean and free from unsightly projections. There are no operating levers except those required for hand motions. All control is by means of "built-in" push buttons and switches. All bolts except those used for clamping tools and for adjusting and clamping heads are of the socket head type and set into counterbores.

The bed and table are extremely deep and heavy. The drive from the motor to the table is by spiral pinion, rack and one pair of helical gears. The thrust on the drive shaft is taken on anti-friction bearings arranged so that no change in temperature will affect the adjustment. The table ways have automatic lubrication by a separate motor-driven pump which supplies filtered oil at two places in each way. The driving motor has a 10 to 1 speed range, providing cutting speed of 20 to 200 feet. The motor is rated at 100 horsepower at 40 feet per minutes and above. The use of limit switches instead of a master switch for automatic reversal has eliminated the necessity for any shifting levers or mechanism, which was a possible source of trouble at high speed.

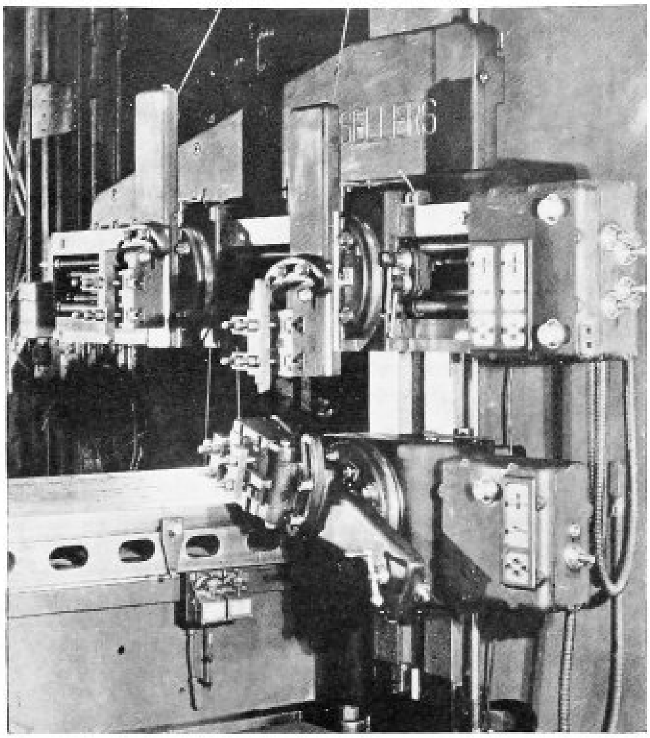
The housing is made exceptionally massive to provide a rigid support for the crossrail which is the most important member of an openside planer for producing accurate work. It is made the same width and depth all the way to the top so as to provide rigidity when the crossrail is in the higher positions and is tied into the bed with an unusually heavy cheek of great depth and width. The width of the face of the housing on which the side head travels is 21 inches. The depth front to back is 79 inches. Due to the small amount of room required for the crossrail mechanism, the face is well backed up with the wall of the housing and it is not necessary to neck down. Horizontal ribs 11 inches apart add to the stiffness by tying the walls and the front face together effectively.

The crossrail is made in two pieces—the front face upon which the heads travel and the rear brace which supports the front face. The two pieces are bolted and doweled together with provision for re-alinement if necessary. The brace is made of welded steel to provide maximum rigidity and strength with minimum of weight.

Powerful clamps, operated by a torque motor through a toggle mechanism, hold the rail rigidly to the housing. They are so arranged that they pull the rail back against the housing face as well as hold it securely so as to keep it in proper alinement.

When the clamps are released the weight of the rail and brace are taken on a hardened steel block on the outside lip of the housing face. This block has a ball seat providing equal distribution of pressure over its entire surface preventing stress concentrations so often occurring in this type of movable member.

The rail and side heads are all of the same size and of extremely heavy pattern. The tool frame holding the clapper box is a steel casting. The other parts are made of a high grade semi-steel. All heads are provided with stainless steel scales and adjustable pointers. A very



Control panel for new planer

while others are being fed. The electrical control is so arranged that while the feed is engaged for any movement, the traverse can be operated in any direction without interfering with the feed.

Stainless steel dials are provided for setting the amount of feed. When several heads are operated simultaneously each may carry a different amount of feed.

The only mechanism located on top of the housing is that for lifting the crossrail. It is comparatively small and is contained in an oil-tight box providing automatic lubrication. The lifting motor is also located on top of the housing and is connected to the box by a coupling. This motor is interlocked with the torque motor for locking the crossrail so that only one push button is required to operate both.

The machine is equipped with seven motors altogether. All electrical equipment is of Westinghouse manufacture. The main driving motor has its separate control panel of the standard planer type. The three feed motors for the heads, the lifting motor, clamping motor, oil pump motor, tool lifters and magnetic clutches are all controlled from one panel which is provided with the necessary interlocks and protective devices required to carry out the various operations. The motor for the oil pump is so arranged that it automatically starts when the line switch is closed insuring proper lubrication to the table before it starts to move.

useful feature is the hand adjustment of the rail heads located at the head as well as at both ends of the rail. Micrometer dials are provided at the heads and at the ends of rail.

All heads are equipped with electrically operated tool lifters built into the slides. The lifters are operated from the limit switches for reversing the table and may be engaged or disengaged by small tumbler switches located in the rheostat panel. Reels carry the cable from the top of the housing to the rail heads, keeping the wire taut at all times so that it cannot get tangled or caught on the work. The electrical tool lifters eliminate a great many small levers, racks, pinions, etc., required in the mechanical tool lifter in order to have it operate in all positions of the slide and at any angle of swivel.

One of the most novel features of this machine is the simplification of the feed and traverse mechanism by means of electrical apparatus. This has made possible the entire elimination of the ratchet boxes, lost motion devices, cranks, bevel gears, levers and more or less complicated gear train. Each head has its own motor which provides both feed and traverse. A worm, worm wheel and one pair of spur gears connecting the motor to the screw and spline shaft constitute the entire mechanical part of the mechanism. The electrical parts include Westinghouse measuring relay, two magnetic clutches, two elevator car switches for feed and the necessary push buttons for traverse.

All the electrical parts are built into the mechanism boxes and not added on the outside. The switches and push buttons are in a compartment entirely separated from the mechanical parts and covered with a stainless steel plate clearly marked with the functions of the various units. Each button or switch is geographically located so that it indicates the direction in which it moves the head. For instance, the traverse button for left hand movement is located at the left of the group, that for moving the slide up is located at the top of the group and so on.

The independent motors permit traversing any head

Accident Rates in Metal Industries

Accident rates in the sheet metal and miscellaneous metal products industries were not altogether favorable during 1934. This is shown by figures just released by the National Safety Council.

In the sheet metal industry, there was no change in the 1934 frequency rate as compared with that of 1933, but the severity rate declined six percent. In the miscellaneous metal products industries, there was an increase of four percent in the 1934 frequency rate and an increase of 28 percent in the severity rate. The results in both of these industries may be compared with increases of five percent in each rate registered by industry as a whole.

Accident rates in the sheet metal industry are based on reports from 184 sheet metal plants whose employees worked 124,949,000 man-hours; those for the miscellaneous metal products industries, on reports from 160 plants whose employees worked 112,725,000 man-hours. The Council determines the injury frequency rate by the number of disabling injuries per one million man-hours of exposure, and the injury severity rate by the number of days lost as the result of disabling injuries per 1000 man-hours of exposure.

In the Council's list of 30 major industries, the sheet metal industry ranks fourteenth on the basis of frequency rate and sixteenth in severity, while the miscellaneous metal products industries rank seventeenth in frequency and fourteenth in severity.

The frequency of disabling injuries has decreased 39 percent in the sheet metal industry, while the severity has decreased 49 percent. In the metal products industries, frequency has decreased 61 percent and severity 30 percent since 1926. These may be compared with a reduction of 57 percent in frequency, and a 37 percent decrease in severity, by industry as a whole.

PRACTICAL PLATE DEVELOPMENT—V

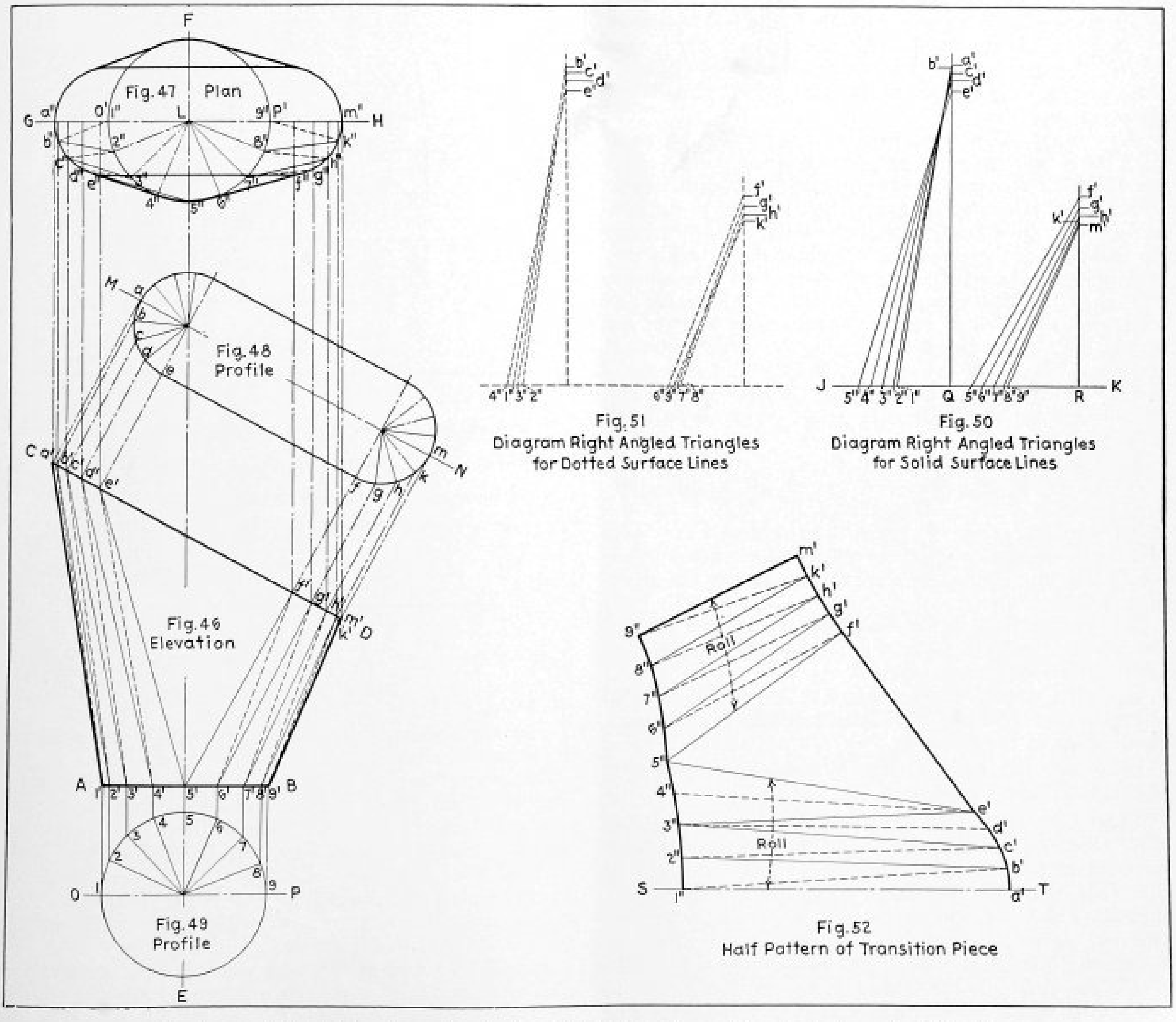
Transition Piece

By George M. Davies

The development of the various pipe connections as illustrated in the previous instalments leads to the development of transition pieces, which are used to a great extent for joining pipes to irregular-shaped connections, such as headers in boilers and to various shaped ducts as used in air conditioning work.

The first transition piece to be considered is illustrated in Fig. 46 and consists of a circular connection at one end, to an oblong connection with semicircular ends, at the opposite end, the oblong section being set at an angle to the circular end.

To develop the transition piece as illustrated in Fig.



Development of transition piece, circular at one end, and oblong with semi-circular ends at the other

46 by triangulation, it is first necessary to construct the plan view, Fig. 47, as follows:

Draw the profile, Fig. 48, making *M-N* parallel to *C-D*.

Divide the semicircular ends into any number of equal parts, eight being taken in this case; the greater the number of equal parts taken, the more accurate the final development. Number these divisions on one side of the center line from *a* to *m* as shown.

Erect perpendiculars to the line *M-N* through the points *a* to *m*, extending same cutting the line *C-D* of the elevation; number these points corresponding to the same number in the profile, Fig. 48, from *a'* to *m'* as shown.

Next through any point as *L* on the center line *E-F* draw *G-H* at right angles to *E-F*. *G-H* will be the center line of the plan view as shown in Fig. 47.

Then parallel to the center line *E-F* draw lines through the points *a'* to *m'*, Fig. 46, extending same into the plan cutting the line *G-H*.

Then step off from the line *G-H*, on the parallel line drawn through the point *b'*, Fig. 46, a distance equal to the perpendicular distance from the line *M-N* to the point *b* in the profile, Fig. 48, locating the point *b"* in the plan. In like manner, step off from the line *G-H*, on the parallel line drawn through the point *c'*, Fig. 46, a distance equal to the perpendicular distance from the line *M-N* to the point *c* in the profile, Fig. 48, locating the point *c"* in the plan. Continue in this manner until the points *d"*, *e"*, *f"* to *m"* of the plan view are located. Connect these points with a line, which will be the plan of the oblong connection.

Next draw the profile, Fig. 49, and divide the semicircle *O-P* into the same number of equal parts as was taken for the ends of the oblong section. Number these points from *1* to *9* as shown. Then parallel to the center line *E-F* draw lines through the points *1* to *9*, cutting the line *A-B* of the elevation. Number these points corresponding to the profile, Fig. 49, from *1'* to *9'* as shown.

Then in the plan view, Fig. 47, with *L* as a center and with a radius equal to one-half the diameter *O-P* of the profile, Fig. 49, scribe a circle cutting the center line *G-H* at *O'* and *P'*. Divide the semicircle *O'-P'* into the same number of equal parts as was taken in the profile, Fig. 49, and number these points correspondingly from *1"* to *9"* as shown.

Next connect the points *1"-a"*, *2"-b"*, *3"-c"*, *4"-d"*, *5"-e"*, *5"-f"*, *6"-g"*, *7"-h"*, *8"-k"*, *9"-m"* with solid lines and *1"-b"*, *2"-c"*, *3"-d"*, *4"-e"*, *6"-f"*, *7"-g"*, *8"-h"*, *9"-k"* with dotted lines. These lines represent the bases of a series of right angled triangles to be constructed to obtain the true lengths of the surface lines in the elevation.

The surface lines in the elevation are obtained by connecting the points *a'* to *m'* with the points *1'* to *9'* with solid and dotted lines as shown.

The next step is to construct a series of right angled triangles to obtain the true length of the solid surface lines shown in the elevation.

Draw any line as *J-K*, Fig. 50, and at the points *Q* and *R* erect perpendiculars to the line *J-K*.

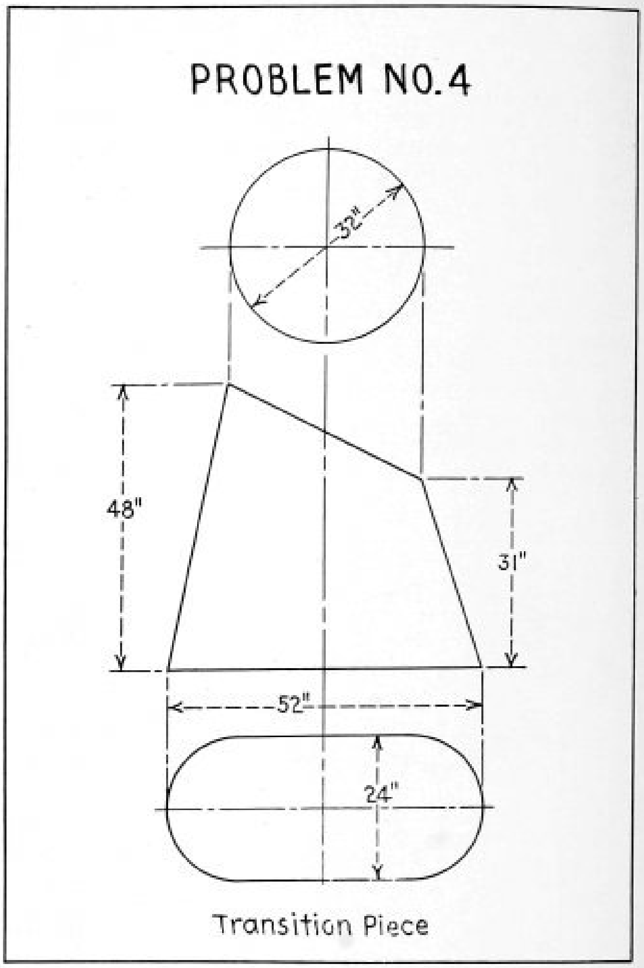
From *Q* on *J-K* step off the distance *Q-1"* equal to *a"-1"*, Fig. 47, and from *Q* on the perpendicular step off the distance *Q-a'* equal to the perpendicular distance from the point *a'* to the line *A-B*, Fig. 46. Connect *a'-1"*, Fig. 50, which line will be the true length of the surface line *1'-a'* of the elevation, Fig. 46. Continue in this manner making the bases *Q-2"*, *Q-3"* to *Q-5"* equal to *b"-2"*, *c"-3"*, to *e"-5"* and the perpendiculars *Q-b'*, *Q-c'* to *Q-e'* equal to the perpendicular distances from the line *A-B* to the points *b'*, *c'* to *e'* in Fig. 46; draw the hypotenuses *b'-2"*, *c'-3"*, *d'-4"* and *e'-5"* which lines are the true lengths of their corresponding surface lines in the elevation.

The remainder of the solid surface lines are obtained in the same manner as shown.

The right angled triangles for obtaining the true lengths of the dotted surface lines shown in the elevation are shown in Fig. 51. These lines are obtained in the same manner as explained for the solid surface lines in Fig. 50. The bases for the triangles are obtained from the plan and the altitudes from the elevation. The hypotenuses obtained are the true length of the dotted surface lines of the elevation.

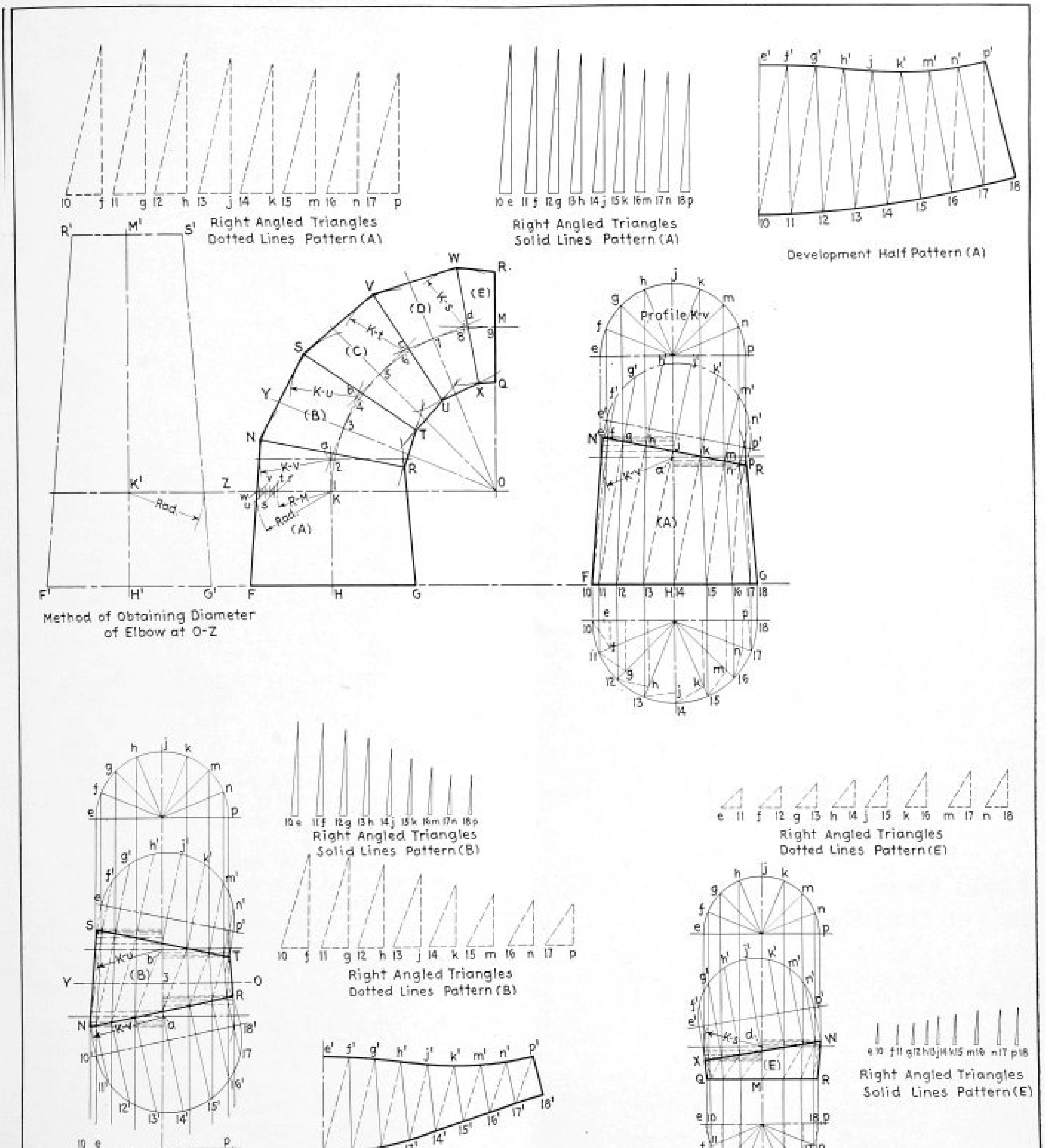
It will be noted in the plan view that the center line *G-H* divides the plan into two symmetrical halves; and therefore a development of one-half of the plan as shown will represent one-half of the complete pattern.

Problem No. 4—For Readers to Layout



Practice Problem No. 4, demonstrates the application of layout principles embodied in the transition piece article in this issue. The correct solution will appear in the October issue

Problem No. 2—Correct Layout



Solution of Practice Problem No. 2, which appeared on page 127 of the May issue

Draw any line as *S-T*, Fig. 52. Step off the distance *1″-a′* equal to *1″-a′*, Fig. 50. Then with the point *a′*, Fig. 52 as a center and with a radius equal to the distance *a-b*, Fig. 48, as a radius, scribe an arc. Then with the point *1″*, Fig. 52, as a center and with a radius equal to the distance *1″-b′*, Fig. 51, as a radius, scribe an arc cutting the arc just drawn, locating the point *b′*, Fig. 52.

Then with the point *1″*, Fig. 52, as a center and with a radius equal to *1-2*, Fig. 49, scribe an arc; then with the point *b′*, Fig. 52, as a center and with a radius equal to *2″-b′*, Fig. 50, as a radius, scribe an arc cutting the arc just drawn, locating the point *2″*, Fig. 52.

Continue in this manner making *2″-3″*, *3″-4″*, *4″-5″* equal to *2-3*, *3-4*, *4-5*, Fig. 49, and *b′-c′*, *c′-d′*, *d′-e′* equal to *b-c*, *c-d*, *d-e*, Fig. 48, and the solid and dotted lines equal to the lengths of their corresponding lines, as shown in the diagram of solid and dotted right angled triangles, until the line *e′-5″* is drawn.

Then with *e′* as a center and with a radius equal to *e-f*, Fig. 48, scribe an arc. With *5″* as a center and with a radius equal to *5″-f′*, Fig. 50, scribe an arc cutting the arc just drawn, locating the point *f′*, Fig. 52.

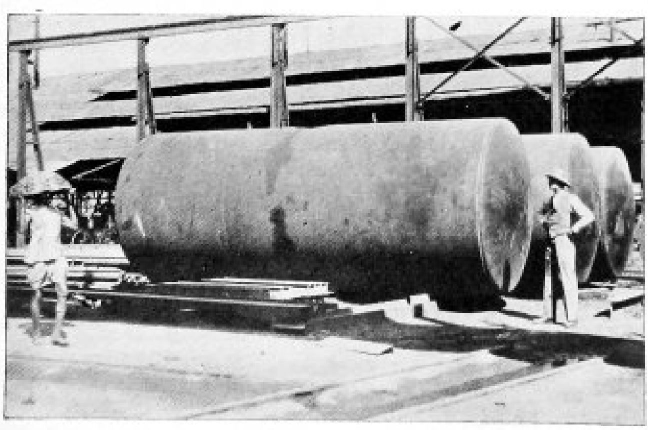
Proceed with the remainder of the pattern in the same manner as outlined, making *5″-6″*, *6″-7″*, *7″-8″*, *8″-9″*, equal to *5-6*, *6-7*, *7-8*, *8-9*, Fig. 49, and *f′-g′*, *g′-h′*, *h′-k′*, *k′-m′* equal to *f-g*, *g-h*, *h-k*, *k-m*, Fig. 48. Also make the solid and dotted lines equal to the lengths of their corresponding lines as shown in the diagram of solid and dotted right angled triangles, until the line *9″-m′*, is drawn completing the half pattern of the transition piece.

The outline shown in the elevation, Fig. 46, and in the profiles, Figs. 48 and 49, are taken on the neutral diameters of the plate, also the pattern does not make any provision for welding the seams. The practice is to bevel the edges of the plates and to prov.de a gap between the plates after they are rolled for making the welds. Allowance should be made in the length and width of the plates, and the edges of the developed plates should be machined for the type of weld required.

(*To be continued*)

India Turns to Arc Welding

India, mother of many an ancient civilization, now uses the newest process known for joining metals. Welding by the electric arc, famed in the Near East in construction of the great Anglo-Persian Iraq pipe line, is used in building an 80-foot boom for a crane—probably the largest welded structure ever undertaken in India—and sixteen 500-gallon tanks (like the three shown) for railway petrol wagons. All welding equipment was supplied by The Lincoln Electric Company, Cleveland.



Arc-welded tanks built in India

Rolling-in Boiler Tubes

(*Continued from page 182*)

record made of the revolutions of the head of the tool and the time in seconds to complete the joint. The results are given in Table 5.

TABLE 5.—CHARACTERISTICS OF THE EXPANDING TOOL

Feed angle of expander, deg.	No. of revolutions of expander head	Time to roll—joint, sec.
1	18¾	150
1¼	17¼	110
1½	17½	90
2	12	60

Conclusions

This paper presents the results of an elementary study of the fundamentals of rolling-in boiler tubes. From these results the following conclusions have been drawn:

1.—The rolling-in of boiler tubes may be broken down into two separate phases; in the first the tube is enlarged until it fits the tube hole; in the second the tube is further expanded into tight contact with the wall of the tube hole. Definite control of these two phases of the operation is necessary if the rolling-in is to produce joints of maximum strength and tightness.

2.—In the usual methods of rolling-in tubes the two phases are not controlled with the result that uniformity of strength and tightness of joints cannot be assured. Records of such rolled-in joints show that some are under-rolled and others are over-rolled. Over-rolling of joints results in heavy cold-working of the metal of the tube and of that surrounding the tube hole, thus setting up points of high-stress concentration with predisposition to corrosion fatigue.

3.—In the "Elongation" method of tube rolling, the two phases of the rolling-in operation are definitely controlled by the use of a dial indicator clamped to the tube being rolled-in. The relationship between elongation and holding strength has been investigated experimentally, using several tube sizes and sheet thicknesses. It appears that the most satisfactory joint is produced when the elongation is about 0.020 inch.

4.—There are several other matters in the tube-rolling problem which merit investigation. Some of these are: (*a*) The effect of the condition of finish of the surfaces to be forced together in rolling-in a joint. (*b*) The effect of the relative hardness of tube and tube sheet on the tightness and holding strength of the joint. (*c*) The effect of grooves in the tube hole on holding strength and rigidity of the joint.

In this paper little has been said about the tool used for rolling-in the joint. This tool, like most others, has been the result of growth over a period of years. There does seem to be a need for some further development in the tools ordinarily used. In the work done in Germany for the Association of Owners of Large Boilers, A. Thum and W. Ruttmann, the investigators, lay great stress on the effect of rate at which the joint is formed. This rate is a function of rate of feed of the tool and the number of revolutions of the tool to form the joint. They have merely touched on this matter and state that it should be studied further.

Calculation of Dome Attachment to Boiler Shell

By C. E. Bronson*

The following calculations for attaching a dome to a boiler shell amplify the explanation given in the Questions and Answers Department of the May issue.

The first step in designing the attachment of a dome to a shell is to calculate the number and size of rivets so that the working stress in tension will not exceed 7200 pounds per square inch, as required in Paragraph P-194, of the A. S. M. E. Boiler Code.

Insufficient data are given in the example as published on page 138 of the May issue, therefore it is necessary to assume a value for the thickness of shell plate, which will be taken as 1¼ inches, making the outside diameter of the dome course 90 inches.

Then the maximum allowable working pressure (P-180) is,

$$\frac{11000 \times 1.25 \times 0.933}{43.75} = 293 \text{ pounds per square inch}$$

The force acting to blow the dome off the boiler is,

$$293 \times 0.7854 \times 51.5 \times 51.5 = 610{,}300 \text{ pounds}$$

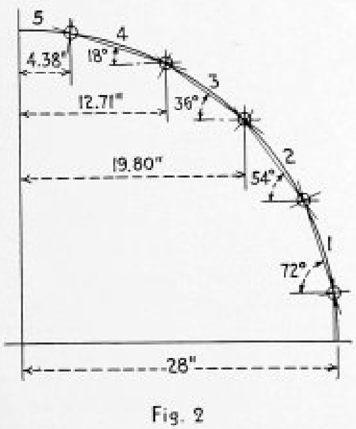


Fig. 2

The working tensile stress in the 80—1⁵⁄₁₆-inch diameter rivets shown in the example is,

$$\frac{610{,}300}{80 \times 0.7854 \times 0.9375 \times 0.9375} = 11{,}050 \text{ pounds per square inch}$$

whereas the Boiler Code limits stress to 7200.

Leaving the number of rivets the same as shown, the size of rivets will need to be increased to,

$$\sqrt{\frac{610{,}300}{80 \times 0.7854 \times 7200}} = 1.161 \text{ inches or } 1\tfrac{3}{16} \text{ inches diameter}$$

When the rivet diameter is increased, the diameter of the dome flange will be increased and will result in a slight increase of the force acting to blow the dome off. In this case, a further calculation shows the rivets capable of allowing a dome flange diameter of 52.6 inches without exceeding the permissible working stress in the rivets.

Having the correct number and size of rivets attaching the dome to the boiler shell, it is now possible to proceed with the calculation of the strength of the shell plate against tearing around through the rivet holes.

Since the shell plate has been pierced with holes for 20 rivets to fasten the reinforcing liner to the shell plate outside the dome flange, there exists the possibility of tearing through these holes. Rivet hole diameter will be assumed as 1³⁄₁₆ inches.

$$\text{Angle of Rivet Spacing} = \frac{360}{20} = 18 \text{ degrees.}$$

$P_1 = 2 \times 28 \times \text{sine } 9 \text{ degrees} = 56 \times 0.1564 = 8.760$ inches.

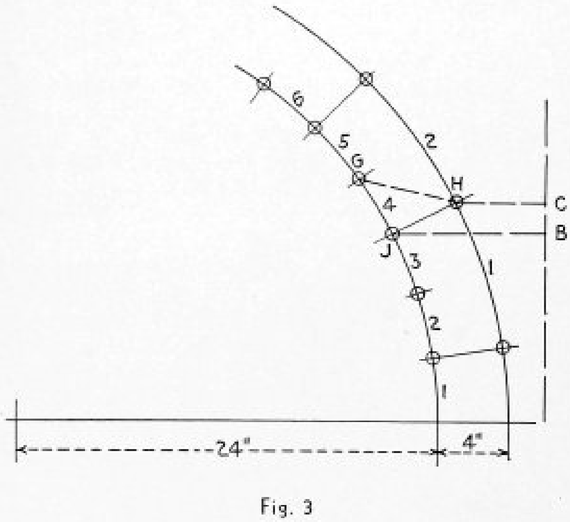


Fig. 3

$$\frac{P_1}{D} = \frac{8.760}{1.1875} = 7.38$$

Ligament	Angle	Cos. Angle	$P_L = \dfrac{P_1}{\text{Cos. Angle}}$	E	$P_L \times E$
1	72	0.309017	2.708	1.46	....
2	54	0.587785	5.150	1.16	....
3	36	0.809017	7.090	0.961	6.81
4	18	0.951057	8.330	0.866	7.21
5	0	½ of (8.76 — 1.1875)		.....	3.78
					17.80
				Multiplied by 2 =	35.60

Equivalent length removed from shell (Fig. 2)
2×19.80 plus 1.188 minus 35.60 = 5.188 inches

$$\text{Efficiency (Rule 1)} = \frac{60 - 5.188}{60} = 91.3 \text{ percent}$$

This value of efficiency is less than the efficiency of the longitudinal joint or 93.3 percent. Therefore, either

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a rearrangement of the rivet holes will be required in order to space them farther apart or else other rivets must be added by extending the reinforcing liner so that their shear value may be added to the tension value of the net section and thus gain the required strength.

In computing the strength according to Rule 2, the equivalent length removed from the shell is (Fig. 2)

2×12.71 plus 1.188 minus $2 \times (7.21$ plus $3.78) =$ 4.628 inches

$$\text{Efficiency (Rule 2)} = \frac{30 - 4.628}{30} = 84.6 \text{ percent}$$

This value meets the requirement of 74.6 percent but the requirement of Rule 1 must be met.

The strength of the shell plate against tearing through the outer row of rivets attaching the dome flange to the boiler is computed as follows:

$P_1 = 2 \times 24 \times \text{sine } 4.5 \text{ degrees} = 48 \times 0.07846 =$ 3.766 inches

$$\frac{P_1}{D} = \frac{3.766}{1.1875} = 3.171$$

Ligament	Angle	Cos. Angle	$P_L = \frac{P_1}{\text{Cos. Angle}}$	E	$P_L \times E$
1	85.5	0.07846	0.296	1.295	.....
2	76.5	0.23345	0.880	1.165	.....
3	67.5	0.38268	1.441	1.035	.....
4	58.5	0.52250	1.968	0.915	1.801
5	49.5	0.64945	2.446	0.825	2.018
6	40.5	0.76041	2.862	0.760	2.175
7	31.5	0.85264	3.211	0.715	2.296
8	22.5	0.92388	3.479	0.690	2.401
9	13.5	0.97237	3.662	0.680	2.490
10	4.5	0.99692	3.754	0.680	2.553
					15.734
				Multiplied by 2 =	31.468

Equivalent length removed from shell (Fig. 3)

2×21.384 plus 1.188 minus $31.468 = 12.488$ inches

$$\text{Efficiency (Rule 1)} = \frac{60 - 12.488}{60} = 79.19 \text{ percent}$$

This efficiency is the ratio of the equivalent net section through line *B-J* ligaments *4*, *5*, *6*, etc., compared to a 60-inch section of solid shell plate. To the strength of this section must be added the shearing value of 8—1$\frac{3}{16}$-inch diameter rivets through the reinforcing liner and shell plate outside the dome flange.

Tensile strength of net section

$$0.7919 \times 60 \times 1.25 \times 11000 = 653{,}300 \text{ pounds}$$

Shearing strength of 8 rivets,

$$8 \times 0.7854 \times 1.1875 \times 1.1875 \times \frac{44000}{5} = 77{,}970 \text{ lbs.}$$

Total strength = 653,300 plus 77970 = 731,270 pounds

$$\text{Efficiency } \frac{731270}{60 \times 1.25 \times 11000} = 88.64 \text{ percent}$$

It is evident that more rivets in shear must be added to increase the strength so as to give the required efficiency of 93.3 percent.

Before computing the number of rivets required it would be advisable to check for the weakest section since rivet *H* (Fig. 3) is close to the dome flange and presents a possibility of reducing the strength of the net section just computed.

Referring to Fig. 3, it will be necessary to determine the efficiency of net section through *C*, *H*, *G* and through ligaments *5*, *6*, *7*, etc.

The equivalent width of ligament *G-H* is:

$5.70 \times \text{cosine } 14.18 \text{ degrees} \times 0.80 = 5.70 \times 0.9695 \times 0.80 = 4.420$

Equivalent length removed from shell along line *H*, *G*, ligament *5*, *6*, etc.

Ligament	$P_L \times E$
G-H	4.420
5	2.018
6	2.175
7	2.296
8	2.401
9	2.490
10	2.553
	18.353 × 2 = 36.706 inches

2×24.948 plus 1.188 minus $36.706 = 14.308$ inches

$$\text{Efficiency (Rule 1)} = \frac{60 - 14.308}{60} = 76.15 \text{ percent}$$

Evidently the net section through *C*, *H*, *G* and ligaments *5* to *10* is the weakest, and additional rivets through the reinforcing liner and shell plate will be required. In arranging these extra rivets care must be taken to preserve the net section at an efficiency not less than the 93.3 percent value for the longitudinal seam in the dome course.

The required number of 1$\frac{3}{16}$-inch diameter rivets will now be calculated.

The tensile strength of the weakest net section is,

$$0.7615 \times 60 \times 1.25 \times 11000 = 628{,}200 \text{ pounds}$$

The required strength is,

$$0.933 \times 60 \times 1.25 \times 11000 = 769{,}700 \text{ pounds}$$

The deficiency in strength is 141,500 pounds.

The number of 1$\frac{3}{16}$-inch diameter rivets required is,

$$\frac{141{,}500}{0.7854 \times 1.1875 \times 1.1875 \times 8800} = 15$$

No attempt will be made to check the adequacy of the reinforcing liner to determine if sufficient metal has been added to replace that removed from the shell plate. This phase has no particular reference to the problem in hand as many boilers are built, especially for oil field service, where the shell plate is not removed but merely pierced with relatively small holes under the dome to permit flow of steam. The problem of strengthening the dome attachment against tearing through the rivet holes is independent of whether or not any shell plate under the dome is removed.

From the foregoing calculations it may be observed that the design of dome attachment shown in the original example does not give a factor of safety of 5. The same is true of many dome attachments on boilers now in service. However, if the rules of the A.S.M.E. Boiler Code are fully observed, safe construction is assured.

Apprentices Needed, Industries Report

A comprehensive and efficient system of apprenticeship training is necessary to supply the lack of skilled labor now facing certain lines of industry, according to the findings of a survey just completed by the National Industrial Conference Board.

In this survey, 287 metal manufacturing companies locating in 21 states reported that the total number of craftsmen needed at once and not now available was 1193, or 1.04 percent of their aggregate employment. With industries operating at normal capacity, the Conference Board estimated that there would be a shortage of about 120,000 skilled workers.

Apprentice training of the future must be something more than has been attempted on any wide scale in the past, in the view of those who participated in the Board's survey. The duty and responsibility of training skilled labor must no longer be assumed only by the larger and public-spirited companies. Each unit must do its share. Small companies should collaborate with other small companies and with their trade associations or the state, but under a program fair to all and comprehensive in its scope. Further, apprenticeship must be made more attractive in order to draw the type of youth who can best profit from the training and in many cases become potential management material.

Better co-operation with trade schools and vocational courses in public schools is urged. Some vocational work attempted in schools has failed to win industry's respect, but there are cases in which excellent work has been done in the way of preliminary instruction and development of aptitudes and leanings. Industry's co-operation will help to improve and expand this work and make it of greater practical value to both employer and employee. Public school co-operation in the teaching of theory can be made a valuable adjunct to apprenticeship courses, as has been found in Wisconsin.

Trade associations and local employers' associations can serve a helpful purpose in co-ordinating and integrating apprentice training in the plants of member companies, as well as by urging on all companies the need of undertaking their share of the training effort. Adoption of uniform standards in the matter of hours of shop work and study, time to be spent in the various stages of training, rates of pay, and attainments to be required for a certificate, together with adequate supervision over the training program, can help materially to assure the usefulness to industry of the product of these courses.

While industrial executives tend to resent the participation of federal or state government in their affairs, it is significant that employers in Wisconsin, the state that pioneered in enacting an apprenticeship law, speak highly of the results of this law and commend such a system to those in other states. This law was enacted in 1911, largely at the instance of employers, and for more than 20 years has made possible an orderly and systematic training of apprentices.

Under this law the Industrial Commission of the state is charged with the administration of the law and supervision over all apprentice training. The commission must approve all work programs for apprentices. It issues rules and regulations for carrying out the provisions of the law. It must approve indentures. It adjusts grievances between apprentices and employers with regard to fulfillment of the provisions of the indenture, and it issues certificates of graduation. It is assisted by committees made up of equal numbers of employers and representatives of the mechanics. The Industrial Commission and employers in the state have worked together closely and harmoniously in bringing about a high standard of training and achievement.

Uncertainty about the future of business tends to discourage the active preparation for future demands which industrial management would normally make, and yet if such preparation is deferred, it will be at the risk of handicapping industry's ability to respond to more active demand when it comes.

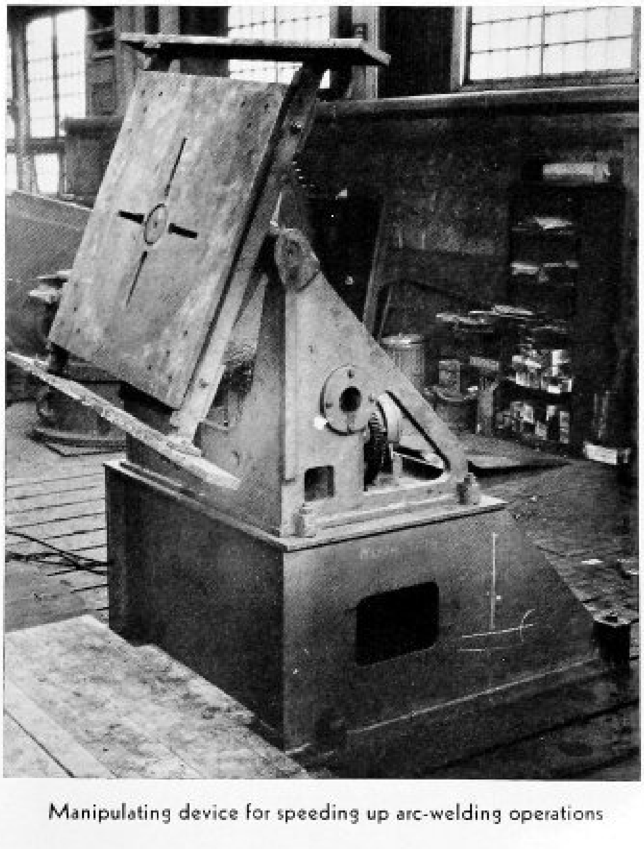
Industry agrees that an adequate system of apprenticeship is indispensable if it is to have the necessary skilled labor in the future. It agrees generally on the fundamentals of such a program: that it must attract the most promising candidates, provide thorough training, absorb the graduates in reasonably remunerative and regular employment, and that, to be effective, all companies must participate in the program, each according to its size and facilities.

It takes time to plan such a program and put it into operation. More time must elapse after the program is in effect before it can show tangible results in the form of regular increments of qualified replacements for the diminishing supply of skilled and versatile machinists. The needs of industry, not next year, but five years and ten years hence, must be planned for now. Measures for meeting this situation cannot be adopted and put into operation too soon.

Welding Manipulator Reduces Handling Costs

A welding manipulator, which permits positioning all work to be welded so that fillet welds of correct radius can be made without waste of electrode metal, and which permits savings of 25 to 40 percent in welding time alone, is announced by the United Engineering and Foundry Company, Pittsburgh. In addition to reducing welding costs and improving the quality of work, this manipulator frees the overhead crane for other duties and eliminates the riggers which are necessary for crane handling.

The welding manipulator, shown in the illustration, is portable and in general consists of a face plate operated by power supplied by an electric motor of the Linc-Weld type manufactured by The Lincoln Electric Company, Cleveland. Operation of the electric motor is controlled by push buttons mounted on an extension cord. By pressure of the proper control button, the face plate can be tilted or rotated to any desired position, the operator riding with the work. Only two handling operations are necessary when using the welding manipulator. These consist merely of placing the work on the face plate for welding and then removing it after welding is completed. Ample provisions for



Manipulating device for speeding up arc-welding operations mounting the work are readily available in the face plate.

Capacity of the manipulator illustrated is from 5 to 7 tons, depending on the center of gravity of the work being handled. Actual figures covering reduced welding costs by use of the welding manipulator, also a copy of a pamphlet entitled "Management of Welding Costs" can be obtained by application to the United Engineering and Foundry Company, Pittsburgh.

First British Turbine Locomotive

By G. P. Blackall

The first British turbine locomotive, in which turbines replace the usual reciprocating steam engines, has just been completed by the London, Midland & Scottish Railroad, Britain's biggest railroad system. This engine is of the *Princess Royal* class and is intended for hauling 500-ton passenger trains between London and Glasgow. It has been built to the designs of W. A. Stanier, chief mechanical engineer of the railroad.

The main motive power unit consists of a multi-stage turbine, which is fitted forward on the left side of the locomotive frame. It is of 2000 horsepower, non-condensing, and uses superheated steam at a pressure of 250 pounds per square inch and a temperature of about 750 degrees F. The power is transmitted to the leading driving axle through triple reduction gear of the double-helical type. For running backwards there is another turbine on the right side, with an additional single-reduction gear, making in all (for reversing) a quadruple reduction gear between the turbine spindle and the driving axle.

The total weight of the locomotive and tender, loaded, is over 183 tons, of which the locomotive accounts for 122 tons. An innovation in it is a double-exhaust type of blast pipe which in turn requires a double-bore stack, enclosed in a single casing.

The steam supply to the two turbines is taken, first, through the main regulator on the boiler (which is kept fully open while the locomotive is in motion) and then to the regulators on the nozzles of the two turbines, there being six of these in the case of the forward turbine, and three in the case of the reverse. They are operated from the cab, and, by means of suitable interlocking devices between the reversing clutch mechanism and the turbine regulators, it is impossible to admit steam to the forward turbine when the reverse turbine is in gear, or *vice versa*.

The boiler has been designed to supply superheated steam at 250 pounds per square inch pressure. The barrel plates and firebox wrapper plates are made of 2 percent nickel steel to keep down weight, and the barrel is tapered. The firebox is extended into the boiler barrel to form a chamber for the more complete combustion of the gases.

A steam manifold is provided on the top of the firebox doorplate in the cab, and carries valves for the injectors, ejectors, steam brake for locomotive and tender, carriage warming, pressure gage, gear case oil-circulating pump, the sight feed lubricator to regulator, and the whistle. The steam supply can be shut off by means of a single valve through which steam is supplied to the manifold.

An exhaust steam injector with 12-millimeter cones is fitted on the right-hand side, and a live steam injector with 13-millimeter cones on the left-hand, or driver's side. The exhaust steam injector feeds through a feed-water heater supplied by steam bled from the forward turbine. Both injectors deliver to the boiler through top feed valves. Sliding trays are fitted beneath the water delivery nozzles inside the boiler to permit periodical cleaning. There are four pop type safety valves, 2½ inches in diameter.

Other boiler mountings, such as water gage frame and protectors, are of the railroad's standard type. The superheater elements are of the bifurcated type from single downcomers, which carry spherical ball joints to the superheater header. The regulator is incorporated with the superheater header casting inside the smokebox. The control for the main regulator is of the usual type, but to insure easy manipulation the handle is balanced, and a small sight-feed lubricator in the cab, controlled by the driver, supplies lubricant to the regulator valve.

Butt and Double-Strap Joint Sawtooth Seam

By Louis R. Haase

In designing longitudinal boiler seams for locomotives which operate at working pressures from 250 to 300 pounds per square inch, where weight restrictions of the boiler are limited, also where it is necessary to have a good tight seam due to high boiler pressure, a butt and double-strap joint sawtooth riveted seam design is of advantage.

The design of inside and outside welt straps is identical and similar, though exaggerated, to the teeth of a large rip saw from which the name was derived.

This type of seam is used on the latest type locomotive boilers of high working pressures although it may be used to advantage on both stationary and marine boilers of all types, particularly the later types of water-tube boilers with riveted longitudinal seams.

Some of the advantages of this type seam are as follows:

The design is the same for inside and outside welt straps, which provides a good calking space, due to the spacing of rivets, eliminating leakage at the seam.

Decreased weight of welt straps over conventional and diamond butt and double strap seams.

Eliminates the buckling of the inside welt strap, such as on a conventional type butt and double strap quintuple riveted seam, where the rivet spacing in the outer row of rivets is large, when driving rivets on bull riveter.

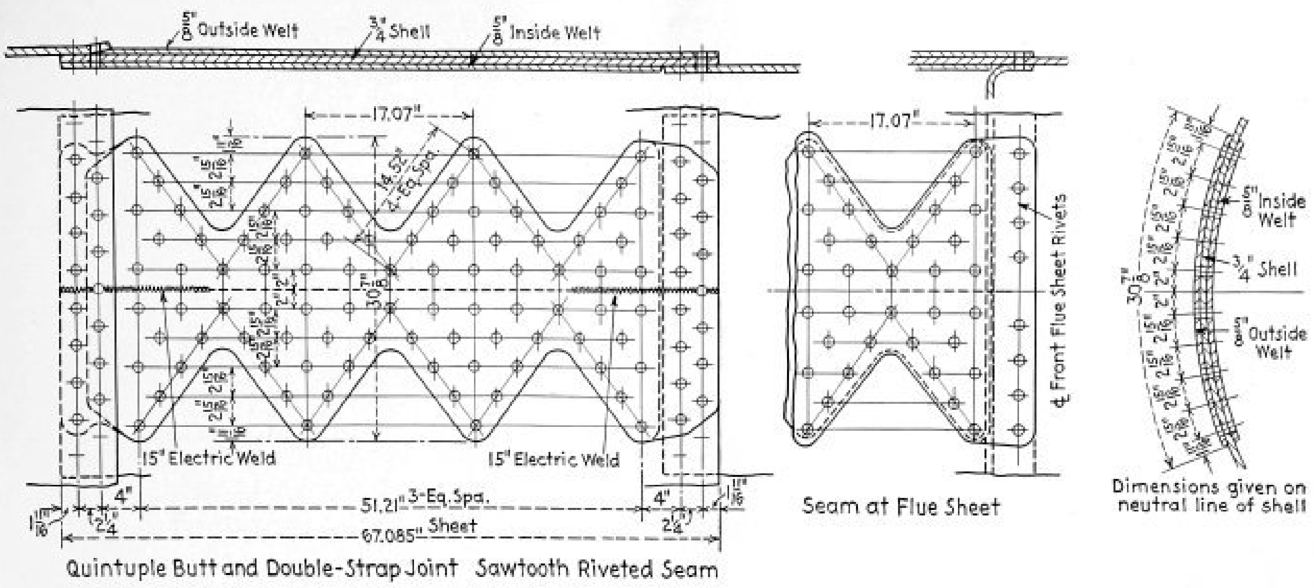
Easy to fit the welt straps to the boiler shell, insuring straps to be up tight before riveting.

Welt straps are smaller in width than quintuple riveted butt joint or diamond seam, thereby taking less room on the boiler shell.

The method of calculating the efficiency of a quintuple-riveted butt joint sawtooth seam is as follows:

This joint may fail in the following ways:

1. Tearing of plate between rivet holes in outside row.
2. Tearing of plate between rivet holes in the second row and shearing one rivet in double shear in first row.
3. Tearing of plate between rivet holes in the third row and shearing two rivets in double shear in second row and one rivet in double shear in first row.
4. Tearing of plate between rivet holes in the fourth row and shearing three rivets in double shear in third row, two rivets in double shear in second row and one rivet in double shear in first row.



Sawtooth design riveted seam for longitudinal joints on locomotive boilers

5. Shearing fourteen rivets in double shear in first, second, third, fourth and fifth rows.

6. Tearing of plate between rivet holes in second row and crushing welt straps in front of one rivet in first row.

7. Tearing of plate between rivet holes in third row and crushing welt straps in front of two rivets in second row and one rivet in first row.

8. Tearing of plate between rivet holes in fourth row and crushing welt straps in front of three rivets in third row, two rivets in second row and one in first row.

9. Crushing plate in front of eight rivets in fourth and fifth rows, three in third row, two in second row and one in first row.

10. Tearing of plate between rivet holes along diagonal row of rivets times factor allowed for angularity.

The following formulas are used to calculate the resistance to failure:

$$(1)\quad \frac{(P-D)\times TS\times t}{P\times TS\times t}$$

$$(2)\quad \frac{(P-2D)\times TS\times t+A\times S}{P\times TS\times t}$$

$$(3)\quad \frac{(P-3D)\times TS\times t+3A\times S}{P\times TS\times t}$$

$$(4)\quad \frac{(P-4D)\times TS\times t+6A\times S}{P\times TS\times t}$$

$$(5)\quad \frac{14A\times S}{P\times TS\times t}$$

$$(6)\quad \frac{(P-2D)\times TS\times t+2(D\times B\times C)}{P\times TS\times t}$$

$$(7)\quad \frac{(P-3D)\times TS\times t+2(3D\times B\times C)}{P\times TS\times t}$$

$$(8)\quad \frac{(P-4D)\times TS\times t+2(6D\times B\times C)}{P\times TS\times t}$$

$$(9)\quad \frac{14D\times t\times C}{P\times TS\times t}$$

$$(10)\quad \frac{(L-4D)\times TS\times t}{L\times TS\times t}\times K$$

Efficiency = Least value obtained in 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10.

Example Showing Application of Formulas

TS = 55,000 pounds per square inch, tensile strength of plate
t = 3/4 inch = 0.75 inch, thickness of shell plate
B = 5/8 inch = 0.625 inch, thickness of welt straps
P = 17.07 inch, pitch of rivets on row having greatest pitch
D = 1 5/32 inches = 1.15625 inches, diameter of rivet after driving
A = 1.05 square inches, cross sectional area of rivet after driving
S = 88,000 pounds per square inch, shearing strength of rivet in double shear
C = 95,000 pounds per square inch, crushing strength of plate
L = 14.52 inches, length of diagonal row of rivets

$K=\dfrac{2}{\sqrt{3\times \text{sine } Y^2+1}}$ Constant allowed for diagonal row of rivets or 1.401

Y = 0.5877 sine angle 36 degrees

Inserting these values in the foregoing formulas we have:

$$(1)\quad \frac{(17.07-1.15625)\times 55{,}000\times 0.75}{17.07\times 55{,}000\times 0.75}=93.2$$

$$(2)\quad \frac{(17.07-2.3125)\times 55{,}000\times 0.75+1.05\times 88{,}000}{17.07\times 55{,}000\times 0.75}=99.5$$

$$(3)\quad \frac{(17.07-3.46875)\times 55{,}000\times 0.75+3\times 1.05\times 88{,}000}{17.07\times 55{,}000\times 0.75}=119$$

$$(4)\quad \frac{(17.07-4.625)\times 55{,}000\times 0.75+6\times 1.05\times 88{,}000}{17.07\times 55{,}000\times 0.75}=151$$

$$(5)\quad \frac{14\times 1.05\times 88{,}000}{17.07\times 55{,}000\times 0.75}=183.7$$

$$(6)\quad \frac{(17.07-2.3125)\times 55{,}000\times 0.75+2\times 1.15626\times 95{,}000}{17.07\times 55{,}000\times 0.75}=117.5$$

$$(7)\quad \frac{(17.07-3.46875)\times 55{,}000\times 0.75+2\times 3\times 1.15625\times 95{,}000}{17.07\times 55{,}000\times 0.75}=173.2$$

$$(8)\quad \frac{(17.07-4.625)\times 55{,}000\times 0.75+2\times 6\times 1.15625\times 95{,}000}{17.07\times 55{,}000\times 0.75}=260.1$$

$$(9)\quad \frac{14\times 1.15625\times 0.75\times 95{,}000}{17.07\times 55{,}000\times 0.75}=163.7$$

$$(10)\quad \frac{(14.52-4.625)\times 55{,}000\times 0.75}{14.52\times 55{,}000\times 0.75}\times 1.401=95.4$$

Efficiency = 93.2 percent

In laying out this seam all dimensions are given on the neutral line of the boiler shell and points are projected radially from the center line of the boiler.

The outside welt strap will be a trifle larger than the inside strap and the circumferential dimensions will change accordingly.

Boiler Manufacturers Elect Officers

At the forty-seventh annual meeting of the American Boiler Manufacturers' Association, held at the Lodge of the Skytop Club, Skytop, Pa., June 10 to 13, the following officers were elected for the coming year:

President—Owsley Brown, Springfield Boiler Company, Springfield, Ill.

Vice-President—S. H. Barnum, The Bigelow Company, New Haven, Conn.

Secretary-Treasurer—A. C. Baker, 709 Rockefeller Building, Cleveland.

Executive Committee (Three years)—Walter F. Keenan, Jr., Foster Wheeler Corporation, New York. E. E. Knobloch, Union Iron Works, Erie, Pa. C. W. Miller, E. Keeler Boiler Company, Williamsport, Pa. A. C. Weigel, Combustion Engineering Corporation, New York. (Two years)—F. H. Daniels, Riley Stoker Corporation, Worcester, Mass. M. E. Finck, Murray Iron Works, Burlington, Ia. A. G. Pratt, Babcock & Wilcox Company, New York. (One year)—A. W. Strong, Strong-Scott Manufacturing Company, Minneapolis. R. B. Mildon, Westinghouse Electric & Manufacturing Company, Philadelphia, Pa. R. B. Dickson, Kewanee Boiler Corporation, Kewanee, Ill. (Ex-Officio)—Owsley Brown, Springfield Boiler Company, Springfield, Ill. S. H. Barnum, The Bigelow Company, New Haven, Conn.

Registration at A. B. M. A. Convention

Aldrich, H. E., Office of A. B. M. A., 15 Park Row, New York, N. Y.
Andrew, J. D., Office of A. B. M. A., 15 Park Row, New York, N. Y.
Ashley, R. E., Muskegon Boiler Company, Muskegon, Mich.
Baker, A. C., Secretary, A. B. M. A., 709 Rockefeller Building, Cleveland, O.
Barnum, G. S., The Bigelow Company, New Haven, Conn.
Barnum, S. H., The Bigelow Company, New Haven, Conn.
Bateman, W. H. S., Detroit Seamless Steel Tubes Company, Philadelphia, Pa.
Bledgett, L. S., Boiler Maker and Plate Fabricator, New York, N. Y.
Brinig, Frank, Erie City Iron Works, Erie, Pa.
Bros, R. J., Wm. Bros Boiler & Manufacturing Company, Minneapolis, Minn.
Brown, C. H., Lukens Steel Company, Coatesville, Pa.
Brown, J. R., Reliance Gauge Column Company, Cleveland, O.
Brown, Owsley, Springfield Boiler Company, Springfield, Ill.
Cardwell, G. A., Lukens Steel Company, Coatesville, Pa.
Carson, W. S., Globe Steel Tubes Company, Milwaukee, Wis.
Champion, D. J., The Champion Rivet Company, Cleveland, O.
Champion, T. P., The Champion Rivet Company, Cleveland, O.
Chipman, F. W., International Engineering Company, Framingham, Mass.
Clarkson, S. N., Class-One Welding Association, New York, N. Y.
Clemens, H. H., Erie City Iron Works, Erie, Pa.
Coburn, J. F., J. F. Corlett & Company, Cleveland, O.
Conarro, H. W., Struthers-Wells-Titusville Corporation, Warren, Pa.
Conlon, W. T., The Superheater Company, New York, N. Y.
Connelly, W. C., Cleveland, O.
Daniels, C. M., Bethlehem Steel Company, Bethlehem, Pa.
Daniels, F. H., Riley Stoker Corporation, Worcester, Mass.
Davis, G. L., Diamond Power Specialty Company, Detroit, Mich.
Dillon, J. F., Jr., Struthers-Wells-Titusville Corporation, Warren, Pa.
Dyer, W. E. S., Edge Moor Iron Company, Edge Moor, Del.
Eury, J. G., Henry Vogt Machine Company, Louisville, Ky.
Felker, G. F., Crosby Steam Gauge & Valve Company, Charlestown, Mass.
Ferguson, Wm., Travelers Indemnity Company, Hartford, Conn.
Finck, M. E., Murray Iron Works, Burlington, Ia.
Fish, E. R., Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn.
Fleming, H. H., Johnston & Jennings Company, Cleveland, O.
Gates, R. M., Superheater Company, New York, N. Y.
Gorden, F. H., Lukens Steel Company, Coatesville, Pa.
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Hobart, R. E., Lehigh Navigation Coal Company, Philadelphia, Pa.
Hobbs, C. H., Detroit Seamless Steel Tubes Company, Detroit, Mich.
Hogan, L. M., Steel & Tubes, Inc., Cleveland, O.
Huyette, P. B., Paul B. Huyette Company, Philadelphia, Pa.
Huyette, S. L., Paul B. Huyette Company, Philadelphia, Pa.
Jones, E. A., Bethlehem Steel Company, Bethlehem, Pa.
Keenan, W. F., Jr., Foster Wheeler Corporation, New York, N. Y.
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Mildon, R. B., Westinghouse Electric & Manufacturing Company, Philadelphia, Pa.
Myers, C. O., Secretary, National Board of Boiler and Pressure Vessel Inspectors, Columbus, O.
Nick, E. W., Northern Equipment Company, Erie, Pa.
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Yarnall, D. R., Yarnall Waring Company, Chestnut Hill, Pa.
Weigel, A. C., Combustion Engineering Corporation, New York, N. Y.
Whiton, L. C., Pratt Daniels Company, New York, N. Y.
Wood, S. C., Wheeling Steel Corporation, Wheeling, W. Va.
Wyankoop, N. O., *Power*, New York, N. Y.

Distributor of Seamless Boiler Tubes

The Pittsburgh Steel Company announces the appointment of the Tubular Service Corporation as distributors of their seamless steel boiler tubes and other pressure tubes in the New England and North Atlantic States. Tubular Service Corporation is located at 120 44th Street (Bush Terminal No. 25) Brooklyn, N. Y.; 721-727 Sedgley Avenue, Philadelphia, Pa., and 23-25 Purchase Street, Boston, Mass.

Acetylene Association to Meet in Cleveland

The International Acetylene Association will hold its 36th annual convention this year in Cleveland at the Cleveland Hotel on November 12 to 15, according to an announcement just issued by the association's secretary, H. F. Reinhard.

Speakers at the technical sessions will include prominent men in many fields of commerce and industry. New developments in the oxy-acetylene process, and their application to industrial problems will be discussed by leading welding engineers.

The unusual interest evinced by all who attended the convention last year has inspired the development of an even more extensive and comprehensive program for this year's meeting. Additional details and copies of the tentative program may be obtained by writing to the association's headquarters at 30 East 42nd Street, New York.

Ryerson Announcements

Edward L. Ryerson, Jr., president of Joseph T. Ryerson & Son, Inc., large steel-service organization, was recently elected to the board of directors of the New York Life Insurance Company. Mr. Ryerson succeeds Alba B. Johnson of Philadelphia who died recently. In addition to his active service as president of the steel company, Mr. Ryerson is also a director of the Northern Trust Company of Chicago, Quaker Oats Company, a trustee of the University of Chicago, and president of the United Community Fund of Chicago, Inc.

E. W. Langdon, manager of the Reinforcing Bar Division of Joseph T. Ryerson & Son, Inc., was recently elected president of the Concrete Reinforcing Steel Institute. This group includes all of the mills selling new billet stock, and rail steel, also jobbers and distributors of reinforcing materials. The Concrete Reinforcing Steel Institute has been organized and has represented the reinforcing industry for the past eight years bearing the same relation to the reinforcing group as the American Iron and Steel Institute bears to the general steel producing industry.

Boiler Maker and Plate Fabricator

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Request for change of address should reach us on or before the 15th of the month preceding the issue with which it is to go into effect. It is difficult and often impossible, to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address, please be sure to send us your old address as well as the new one.

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EDITORIAL STAFF: H. H. Brown, Editor. L. S. Blodgett, Managing Editor

Contents

Proposed Rivet Standards

A proposed American Standard for Large Rivets, ½ inch nominal diameter and larger, has recently been completed by Subcommittee No. 1 of the Sectional Committee on the Standardization of Bolt, Nut and Rivet Proportions. This proposed standard represents a second revision of an earlier proposed American Standard for Large Rivets dated October, 1928, and is now being distributed to industry for criticism and comment. Copies are available on application. All communications should be addressed to C. B. LePage, assistant secretary, The American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y.

The standardization of large rivets is one of the nine subdivisions of the project assigned to the Sectional Committee on the Standardization of Bolt, Nut and Rivet Proportions, of which Professor A. E. Norton is chairman. This committee was organized under the procedure of the American Standards Association in 1922, with the Society of Automotive Engineers and The American Society of Mechanical Engineers as joint sponsors.

Booklet on the Metallurgy of Oxy-Acetylene Welding of Steel

The Linde Air Products Company, 30 East 42nd Street, New York, announces publication of "The Metallurgy of Oxy-Acetylene Welding of Steel." This booklet, by J. H. Critchett, vice-president of the Union Carbide and Carbon Research Laboratories, Inc., is an exceptionally informative discussion of the physical and chemical principles involved in the oxy-acetylene welding of steel. It merits recognition as an authoritative publication on an important industrial subject.

Using non-technical language that is easily understood, the author compares by analogy the metallurgy of open hearth practice with that of steel welding. The study, therefore, covers physical changes such as expansion and contraction, metallurgical effects such as crystallization, heat-treatment and the effect of alloys, and the chemical reactions of steel with its surrounding materials. An accurate metallurgical study of a welded system, according to the author, is quite difficult, because the metal adjacent to the welded joint has all graduations of temperature from normal up to that of liquid metal. The results of this difficult research are elucidated.

The discussion includes an interesting presentation of the metallurgical factors which led to the development of modern welding rods and of the carburizing flame technique for welding steel. The advantageous heat effects of the oxy-acetylene flame are also discussed.

New Directory of Steel Plants Issued

Essential details, so far as reported, of all companies, firms and individuals known to be now engaged in the iron and steel industry in the United States and Canada are contained in the 22nd edition of the Directory of Iron and Steel Works of the United States and Canada, which has just been issued by the American Iron and Steel Institute, New York.

The new Directory represents a complete revision and bringing up to date of the information published in the 1930 edition.

As in previous editions, the main part of the new directory consists of a list of the concerns engaged in the iron and steel industry, with as full details as practicable relative to each.

To facilitate comparisons with earlier editions of the Directory, a special list has been included in this edition containing appropriate reference to all concerns which were listed in the 1930 edition but which have since that date gone out of business, been combined with other companies, or changed ownership and corporate name.

Another new feature of this edition appears in the supplementary lists, which show for each of the principal classes of products the name of each producer and its reported capacity. All estimated capacities reported for use in this Directory have been related to available steel supply or to actual performance in production. It is believed, therefore, that the data presented in this edition accurately represent the status of the industry as it entered the year 1935.

The new edition contains more than 450 pages. The price per copy, bound in cloth, is $8 postpaid to members of the Institute and to booksellers, and $10 postpaid to non-members of the Institute.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on practical boiler shop problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given special permission to do so.

By George M. Davies

Patches on Boilers

Q.—Please explain the meaning of a soft patch and a hard patch on a boiler.—S. H. K.

A.—A soft patch is a patch put together by bolts or screw studs and usually is of a somewhat temporary nature. A hard patch is a patch secured by riveting and is a permanent repair. These terms were in use before welding was developed, but a patch welded on would be considered a hard patch.

Boiler Patch for Horizontal Return Tubular Boilers

Q.—I would like to have the rules for computing boiler patch for horizontal return tubular boiler as they require in Ohio.—J. E. R.

A.—The Ohio Boiler Inspection laws and rules for computing boiler patches for horizontal return tubular boilers are as follows:

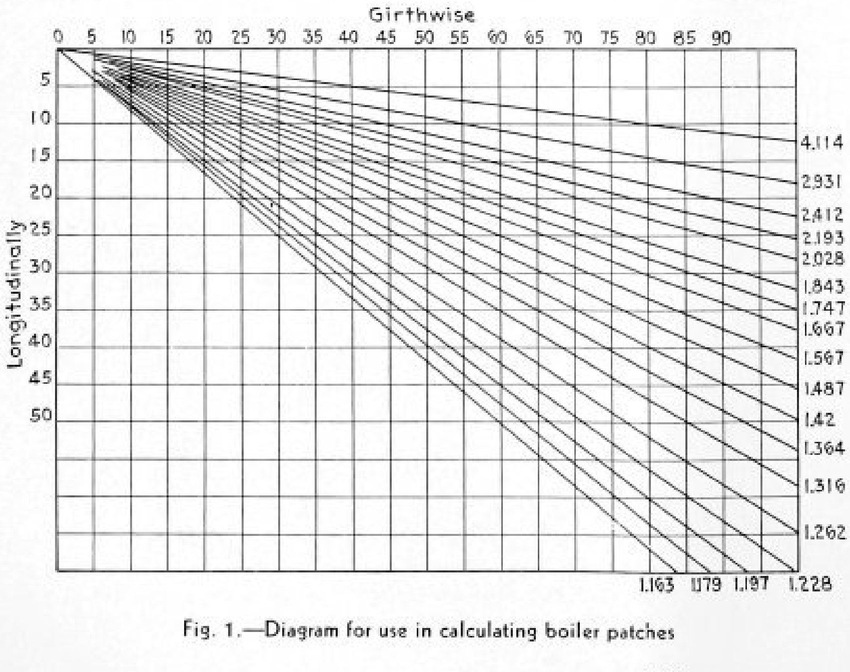

Fig. 1.—Diagram for use in calculating boiler patches

Whenever a shell or drum is repaired by placing a patch, a new long form data report covering the boiler and a sketch of the patch in detail, shall be forwarded to the Boiler Inspection Department.

A patch exceeding 20 inches in length, (measured longitudinally with the shell or drum from center to center of rivet holes), shall meet the requirements of P-261 and P-180, except a patch exposed to furnace temperatures (as in the case with return tubular and other boilers of similar types), may be single riveted, and where the length of the patch (measured longitudinally with the shell or drum from center to center of rivet holes) exceeds 20 inches, the angularity of the patch seam, size and pitch of rivets, shall be such that a factor of safety of five will be obtained based on the maximum pressure to be allowed. The distance from the center of rivet holes to the edge of plate shall be not less than 1½ times the diameter of the rivet holes.

Plate Thickness Inches	Rivet Hole Diameter Inches	Minimum Pitch Inches
1/4	11/16	1 5/8
5/16	3/4	1 7/8
3/8	13/16	1 15/16
7/16	15/16	2 1/4
1/2	15/16	2 1/16
9/16	1 1/16	2 3/8
5/8	1 1/16	2 3/4

Explanation of the diagram shown in Fig. 1.

1. Obtain the efficiency of single riveted patch seam by ordinary method (A. S. M. E. Code).
2. Efficiency of longitudinal seam of boiler divided by ordinary ordinary efficiency of patch seam equals "factor."
3. Ordinary efficiency of patch seam times "factor" equals "effective efficiency" of patch seam. Follow horizontal line representing length of patch to point of intersection with diagonal line of the nearest factor, then follow the next vertical line to the right, which will indicate at the top of the diagram the minimum required girthwise width of the patch.

Example No. 1.—A horizontal fire tube boiler 66 inches in diameter is to be repaired by removing a section of the shell plate over the furnace and installing a single riveted patch. The patch is to be 25 inches longitudinally from center of head seam to center of patch seam. What width should the patch be girthwise to maintain the allowable pressure of 125 pounds? The thickness of the shell is 7/16 inches, triple riveted longitudinal seam; 87.9 percent joint efficiency.

Solution. From table for plate thickness it is noted that the diameter of rivet hole in patch seam is given as 15/16 inches and the pitch 2¼ inches.

(1) Obtain the efficiency of this seam by the ordinary method.

(A) $P \times t \times TS = 54{,}141$
(B) $(P\text{-}d) \times t \times TS = 31{,}582$
(C) $a \times S = 30{,}373$
(D) $t \times d \times c = 38{,}965$

$$\frac{C}{A} = 56.1 \text{ percent}$$

P = pitch of rivets in inches, $2\frac{1}{4}$ inches
d = diameter of rivet hole, 0.9375 inch
a = cross sectional area of rivet after driving = 0.69029 inch
S = shearing strength of rivet in single shear = 44,000 pounds per square inch
C = crushing strength of mild steel = 95,000 pounds per square inch

(2) Efficiency of longitudinal seam of boiler divided by ordinary efficiency of patch seam equals "factor."

Efficiency longitudinal seam = 87.9
Effective efficiency patch seam = 56.1

$$\text{Factor} = \frac{87.9}{56.1} = 1.566$$

From the table of factors it is noted that the patch must be 60 inches in width girthwise in order to maintain the pressure.

Example No. 2.—A patch 33 inches longitudinally by 60 inches girthwise is found on shell plate over furnace of a horizontal fire tube boiler 66 inches in diameter. The seam of patch is single riveted, $2\frac{1}{4}$ inch pitch, $\frac{15}{16}$ inch rivet holes. The thickness of shell plate of boiler is $\frac{7}{16}$ inch; longitudinal seam triple riveted; 87.9 percent joint efficiency. What is the maximum allowable working pressure of boiler?

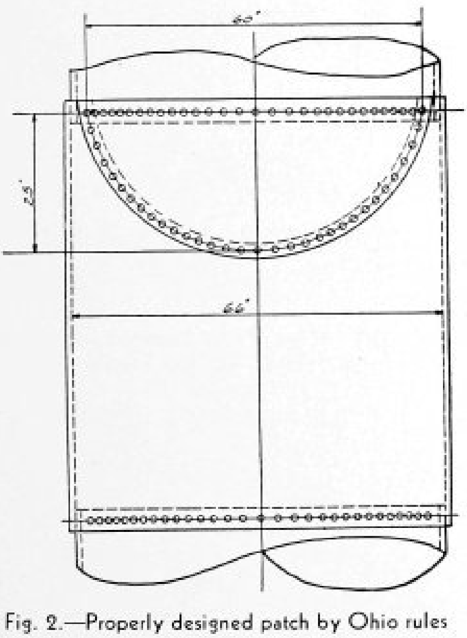

Fig. 2.—Properly designed patch by Ohio rules

Solution.—(1) Obtain the efficiency of patch seam by ordinary method. This is the same as Example No. 1 and is 56.1 percent.

(2) Obtain "factor" from diagram. This is 1.34 (about).

(3) Multiply ordinary efficiency of patch seam by "factor" and result will be effective efficiency of patch seam.

$$56.1 \times 1.34 = 75.174 \text{ percent}$$

(4) Obtain the allowable working pressure by formula in Par. P-180.

$$\text{Allowable pressure} = \frac{t \times TS \times E}{R \times FS}$$

$$\text{Allowable pressure} = \frac{0.4375 \times 55{,}000 \times 75.174}{33 \times 5} = 109 \text{ pounds}$$

Fig. 2 illustrates a properly designed patch as required by the Ohio Boiler Rules.

Stayed Wrapper Sheet

Q.—In your April issue, on page 112, you publish the formula for figuring the maximum allowed pressure of a stayed wrapper sheet of a locomotive boiler. If you had a double riveted lap joint, $\frac{7}{8}$-inch rivets, $\frac{15}{16}$-inch holes, pitch of rivets $2\frac{13}{16}$ inches without cover plate between the stays marked $8\frac{1}{8}$-inch, just below the staybolt marked *A*; how would you figure the allowable working pressure? Would the strength of the stays give any support to the seam or would the seam be figured just a double-riveted joint? F. J.

A.—The seam would be figured as a double-riveted lap joint and the efficiency obtained as follows:

A = strength of solid plate = $P \times t \times TS$
B = strength of plate between rivet holes = $(P\text{-}d)\ t \times TS$
C = shearing strength of one rivet in single shear = $n \times s \times a$
D = crushing strength of plate in front of one rivet = $n \times d \times t \times c$.

Divide *B*, *C* or *D* (whichever is the least) by *A*, and the quotient will be the efficiency of a double-riveted lap joint, where

TS = tensile strength stamped on plate, pounds per square inch
t = thickness of plate, inches
P = pitch of rivets, inches, on row having greatest pitch
d = diameter of rivet after driving, inches, diameter of rivet hole
a = cross-sectional area of rivet after driving, square inch
s = shearing strength of rivet, in single shear, pounds per square inch
c = crushing strength of mild steel, pounds per square inch
n = number of rivets in single shear in a unit length of joint.

Substituting the values in the question we have

$TS = 55{,}000$ (assumed)
$t = \frac{9}{16}$ inch
$d = \frac{15}{16}$ inch
$P = 2\frac{13}{16}$ inches
$a = 0.6903$ square inch
$s = 44{,}000$ pounds
$n = 2$
$c = 95{,}000$ pounds

$A = 2.6875 \times 0.5625 \times 55{,}000 = 83{,}144$
$B = (2.6875 - 0.9375) \times 0.5625 \times 55{,}000 = 54{,}140$
$C = 2 \times 44{,}000 \times 0.6903 = 60{,}746$
$D = 2 \times 0.9375 \times 0.5625 \times 95{,}000 = 100{,}195$

$$\frac{54{,}140}{83{,}144} = 65.1 \text{ percent, efficiency of lap joint.}$$

In the formulas given in Par. P-212 (*a*) as stated in the April issue, it will be noted that both formulas compute the allowable working pressure without the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays or riveted longitudinal joint or other construction. In the problem this pressure was found to be 97.5 pounds.

Had the efficiency of the lap joint computed above fallen below the efficiency of 57.8 percent from which the above boiler pressure was computed, then the working pressure would have had to be based on the efficiency of the lap joint.

Thus in this case the application of a lap joint as illustrated in the question would not affect the working pressure of the boiler as computed in the April issue.

In computing the maximum allowable working pressure for the wrapper sheet by the formula

$$P = \frac{TS \times t \times E}{FS \times R}$$

the efficiency *E* should always be taken through the point of lowest efficiency, whether it is through the longitudinal joint or through the staybolt holes. Otherwise the application of a longitudinal lap joint does not affect the maximum allowable pressure on the wrapper sheet.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.

Assistant Chief Inspectors—J. M. Hall, Washington, D. C.; J. A. Shirley, Washington, D. C.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Assistant Director—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.

Vice-Chairman—D. S. Jacobus, New York.

Acting Secretary—M. Jurist, 29 W. 39th Street, New York.

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Vice-Chairman—F. A. Page, San Francisco, Cal.

Statistician—L. C. Peal, Nashville, Tenn.

International Brotherhood of Boiler Makers, Welders, Iron Ship Builders and Helpers of America

International President—J. A. Franklin, Suite 522, Brotherhood Block, Kansas City, Kansas.

Assistant International President—J. N. Davis, Suite 522, Brotherhood Block, Kansas City, Kansas.

International Secretary-Treasurer — Chas. F. Scott, Suite 506, Brotherhood Block, Kansas City, Kansas.

Editor-Manager of Journal — John J. Barry, Suite 524, Brotherhood Block, Kansas City, Kansas.

International Vice-Presidents—Joseph Reed, 1123 E. Madison Street, Portland, Ore.; W. A. Calvin, 1622 Glendale Street, Jacksonville, Fla.; Harry Nicholas, 6215 S. Benton Blvd., Kansas City, Mo.; W. E. Walter, 637 N. 25th Street, East St. Louis, Ill.; J. H. Gutridge, 910 N. 18th Street, Milwaukee, Wis.; W. G. Pendergast, 26 South Street, New York, N. Y.; W. J. Coyle, 424 Third Avenue, Verdun, Montreal, Quebec, Can.; A. M. Milligan, 262 Trent Avenue, East Kildonan, Man., Can.; J. F. Schmitt, 28 S. Roys Street, Columbus, Ohio; William Williams, 502 Labor Temple, Portland, Ore.

Master Boiler Makers' Association

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Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, Ohio.

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Vice-President—S. H. Barnum, The Bigelow Company, New Haven, Conn.

Secretary-Treasurer—A. C. Baker, 709 Rockefeller Building, Cleveland.

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OFFICE OF INDUSTRIAL RECOVERY COMMITTEE, 15 PARK ROW, NEW YORK

Manager—James D. Andrew.

Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President—Murrel J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

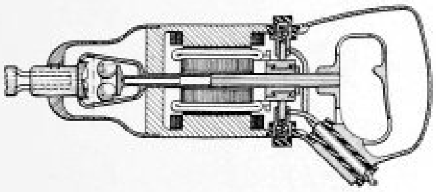
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent Attorney, 1372-1376 National Press Building, Washington, D. C. Readers wishing copies of patents or any further information regarding any patent described, should correspond directly with Mr. Galt.

1,856,336. STRIKING TOOL. ERIK GUSTAF HYSING, OF STOCKHOLM, SWEDEN, ASSIGNOR TO AKTIEBOLAGET NORDISKA ARMATURFABRIKERNA, OF STOCKHOLM, SWEDEN, A LIMITED COMPANY.

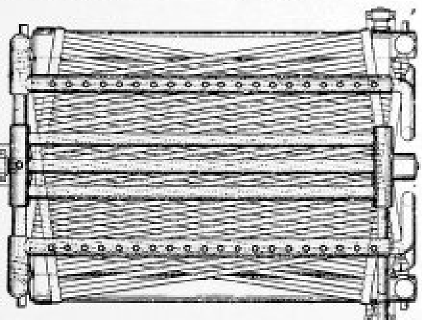
Claim.—A striking tool including an anvil having at least one oblique impact surface, a striking member rotatably and reciprocably mounted



with respect to the anvil and provided with at least one striking face in the form of a ball for coacting with the impact surface in the anvil for effecting a recoil movement of the member, the axis of rotation of said striking member substantially coinciding with the axis of the anvil, and a guiding and rotating device cooperating with the ball to cause the latter to deliver blows upon the anvil.—Nine claims.

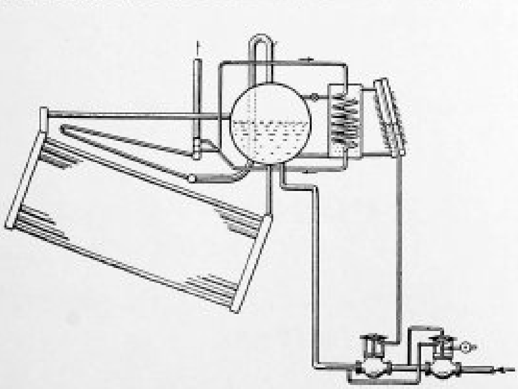
1,883,145. STEAM GENERATOR. ROY M. WARFIELD, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, OF ONE-THIRD TO STANLEY STEAM MOTORS CORPORATION, A CORPORATION OF DELAWARE.

Claim.—A vapor generator comprising a plurality of banks of inclined tubes for containing liquid to be heated; upright headers; means for re-



movably connecting said banks to said headers, said banks being substantially rectangular in form; some of said banks being arranged diagonally in one direction, and the other banks arranged diagonally in the opposite direction for forming a crisscross grid, for increasing efficiency of the generator. Eleven claims.

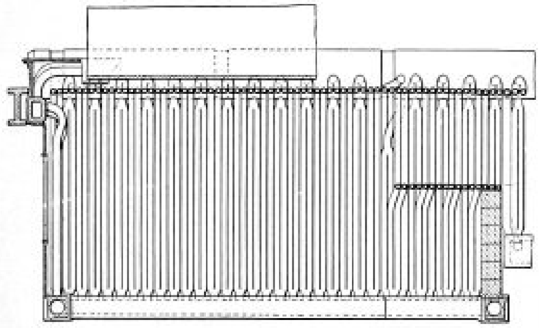
1,881,225. BAFFLING MEANS FOR LOCOMOTIVE FIREBOXES. HENRY B. OATLEY, OF GREAT NECK, NEW YORK, ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y.



Claim.—A firebox having a hollow foundation ring, means forming longitudinal water cooled walls for the firebox, transverse tubes arranged longitudinally of said firebox having their upper ends connected into said means at the diagonally opposite corners thereof from their lower ends, and a refractory baffle at the front of the firebox resting on said ring and held in place by said tubes, said foundation ring having inwardly projecting shoulders near the forward end of said firebox into which the diagonally extending tubes are connected. Three claims.

1,883,950. METHOD OF AND APPARATUS FOR FEEDING WATER TO BOILERS. JOSEPH KISSICK, OF WHITE PLAINS, NEW YORK, ASSIGNOR TO KISSICK-FENNO CO. INC., A CORPORATION OF NEW YORK.

Claim.—The method of feeding water to a boiler according to water level and boiler output which consists in causing the inflow to substantially



equal the outflow while the load is constant, and in causing the rate of change of inflow to exceed the rate of change of outflow while the inflow and the outflow increase, and in causing the rate of change of inflow to be greater than the rate of change of outflow while the inflow and the outflow decrease. Ten claims.

Have You Changed Your Address?

Notice of change of address of subscribers should reach the office of *Boiler Maker and Plate Fabricator*, 30 Church St., New York, ten days in advance to insure delivery of the following issue to new address. Also mention your former address.

Boiler Maker and Plate Fabricator

Master Boiler Makers Appeal to Superintendents of Motive Power

For several months past officers and committees of the Master Boiler Makers' Association have worked indefatigably in the preparation of an outstanding program of papers for presentation at the business meeting to be held at the Hotel Sherman in Chicago on September 18 and 19. This work has been carried almost to the point of completion in spite of considerable opposition from certain official circles.

When it is fully realized by officers of the Association of American Railroads that this hard-working group of practical artisans is making a courageous attempt to save a valuable organization from extinction in order that, in the future, it may function to the everlasting benefit of the railroads, as it has in the past, it cannot be conceived that less than complete official approval will be given the effort.

For thirty years the Master Boiler Makers' Association existed as an independent entity and, in the course of that time, produced information on practical phases of locomotive boiler construction, inspection, maintenance and repair that placed it in the front rank of the lesser mechanical associations serving the railroads. The only justification for the existence of the association has been and still is the ability of its membership to add to the fund of knowledge concerning locomotive boiler practice. That this has been recognized is evidenced by the wholehearted support of mechanical officials throughout the country, whose authorization has been essential to attendance at conventions of individual members.

For the past five years economic conditions have not permitted the association to meet in convention. In spite of this curtailment of its activities the officers, particularly the secretary, have used every available means to keep the membership interested in association work, so that no lapse might occur when the convention feature was resumed.

In 1931 proceedings were published, containing addresses of high railroad officials as well as committee reports that had been prepared for a convention, which was never held. In October, 1933, a complete "Convention in Print," covering important developments in the art of boiler making, was presented to the railway industry through the medium of this publication. The information thus made available by the association was distributed throughout the membership and among railway mechanical officials generally.

Early in 1935, when a two-day business meeting was proposed for September, with every evidence of approval by the Association of American Railroads, the officers of the Master Boiler Makers' Association seized upon it as an opportunity to bring all the important members of the organization together again. This business meeting has not in any sense been interpreted as a convention but rather as a round-table gathering to discuss the future of the association. More than this, however—it has been recognized as the first chance in five years to collect valuable first-hand information on boiler maintenance problems, which would repay the railroads many times over for the support, evidenced by superintendents of motive power in sending their representatives to the meeting.

It has been considered that a business meeting amplified to include officers, committee members, and members of the association holding important supervisory posts, would be able in a two-day session to solve many of the troublesome problems in boiler work that have arisen in recent years. To the end that these members might be authorized to represent their several railroads, a personal appeal was recently sent by the secretary to every superintendent of motive power. The individual responses from mechanical officials, offering their support, have assured a completely successful meeting.

In view of this overwhelming approval expressed by railroad officials, who believe this meeting will be productive of information valuable to their railroads, the hope has been earnestly expressed by officers of the association that the Association of American Railroads will give this business meeting official sanction and support. While the Master Boiler Makers' Association is in no way affiliated with the Association of American Railroads, the lack of interest, and, in fact, direct opposition from certain official quarters, has militated against the attempt now being made to keep the association together. This policy of antagonism should be altered and the courage and vitality of this association of master boiler makers in attempting to function in the face of difficulties should be encouraged officially. The future success of the railroads will depend largely upon these same qualities in their personnel, which are now being expressed by the master boiler makers.

An important feature of conventions; namely, exhibits of materials, tools and equipment will, of course, not be made at this business meeting. Nevertheless, it is to be expected that supply company representatives, who in the past have been interested in the work of the Master Boiler Makers' Association, will loyally support the valiant effort now being made again to become an active factor in advancing the technique of locomotive boiler maintenance.

Without a formal convention and the opportunity thus afforded to exhibit their products, there is probably but little that the supply companies can do to show their interest in this meeting. They can, however, give their moral support and in many cases will find it worthwhile to delegate representatives to be in attendance at the meeting.

C.G.W. Mikado locomotive just outside Oelwein shops

Chicago Great Western modernizes locomotive

MAINTENANCE FACILITIES

During the past four years the Chicago Great Western has initiated and carried to practical completion a program of improvement of its locomotive maintenance facilities at Oelwein, Iowa, which places this road in an admirable position to keep motive power in good working condition at minimum expense. When the 36 2-10-4 freight locomotives were received on the Great Western in 1930, it was found that the facilities at the Oelwein locomotive shops were entirely inadequate, as the pits in the shop were too short; the transfer table was not strong enough; the hoist for lifting locomotives while unwheeling did not have sufficient capacity; and the machine-tool equipment was, to a great extent, obsolete.

To relieve this condition temporarily, it was decided to install enough new facilities and machinery at the Oelwein engine house to permit giving light classified repairs to the 2-10-4 type locomotives and keep them in service until such time as they were due for general overhauling and heavy boiler repairs. With this end in view, a Whiting 50-ton electric drop table, with pit connection to five tracks, was installed early in 1931, making it possible to remove or apply a pair of driving wheels in about six minutes, as compared with 20 minutes formerly required. Twenty-one modern machine tools were also installed, including a Niles 90-inch heavy-duty driving-wheel lathe, Micro portable crank-pin grinder, a Bullard 24-inch vertical turret lathe, two new Duff-Norton 100-ton jacks, a Baker electric crane truck, three jib cranes, etc.

Subsequently, authority was granted to remodel completely the Oelwein locomotive shop, and this work was started in July, 1933. A total of 27 new machines was installed. A Whiting 250-ton, four-jack locomotive hoist was located in a pit which extends into the old Mallet house, and it is now possible to remove all of the driving wheels, engine truck, trailer truck and booster wheels from a 2-10-4 type engine in about 50 minutes, replacing them in about 1 hour 45 minutes.

Four of the pits in the backshop were completely rebuilt and extended back underneath the balcony, in order to give them sufficient length to accommodate the new locomotives. The unique feature of these pits is the fact that they do not extend to the back end of the locomotive, the portion of the floor underneath the firebox being built up to the track level. As the trailer truck previously has been removed on the locomotive hoist, it is possible to work on the firebox while standing on the floor, and a pit is not needed at this end.

Practically all of the old wooden plank floor was removed and a concrete floor now extends over most of the shop, thus greatly facilitating the movement of material by means of trucks and tractors. Another feature is the provision of suitable work benches, racks and platforms so that no locomotive parts or materials are permitted to be on the floor at any time. This contributes both to neatness and to shop efficiency.

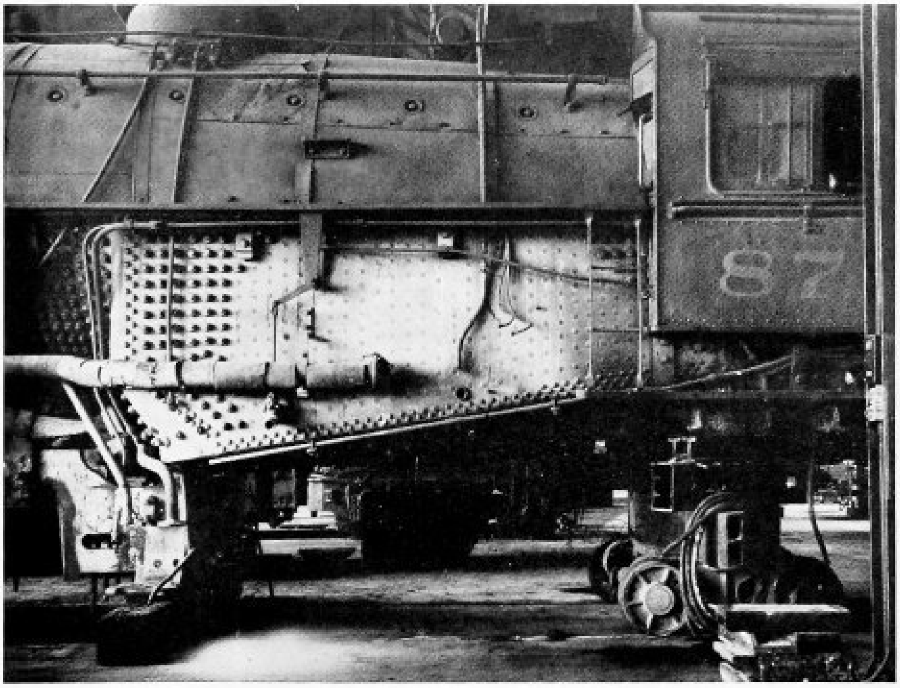
In laying out the shop it was found that there was not sufficient floor space on the machine side to take care of all of the machine work, and, for this reason, it was necessary to fill in several erecting pits and use this portion of the shop for machine tools. Five pits in the south end of the machine shop were filled in and covered with a concrete floor, this portion of the shop being now utilized for the repair of air-brake equipment, valve gears, injectors, lubricators, power-reverse gears, and other special appliances.

The tool room arrangement and equipment were completely revised, several old machines being retired and replaced by modern equipment, including a Monarch 18-inch engine lathe, a Cincinnati No. 2 cutter grinder and a Cincinnati No. 3 universal milling machine. In addition, over 700 carbon-steel drills, reamers, wrenches, pneumatic tools, etc., were scrapped, and replaced by modern equipment. These small tools, kept on modern steel tool racks and shelving, are now issued on checks by a competent tool room attendant. When tools are returned to the tool room, their condition is carefully checked and repairs made when necessary. Pneumatic tools used in the shop are left on the job at quitting time, but a night tool room attendant takes these tools back to the tool room each night for careful inspection, lubrication and testing, then returning them to the respective shop departments where they are available in good condition ready for operation just as soon as the shop whistle blows in the morning.

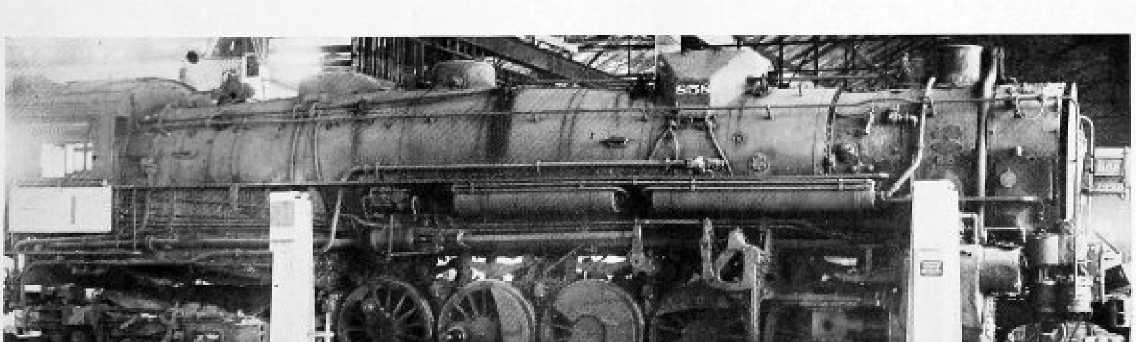
In deciding what machines were to be replaced in this modernization program, the production needs of the shop were given first consideration. A total of 122 machines, most of which were obsolete, belt-driven tools, were retired in the locomotive shop and 13 old machines in the engine house. So great has been the improvement in productive capacity of modern machine tools that it was not necessary to replace all of the old tools. As a matter of fact, 27 new machines were installed in the locomotive shops and 21 in the engine house.

Since installing the new shop equipment at Oelwein shops and revising the organization, it has been possible to maintain a fairly uniform force. Sixty-five men have been used in the locomotive department 40 hours a week and the output has averaged 3½ Class-3 repairs to the 2-10-4 type locomotives per month. The improved shop condition has enabled better work to be turned out in about one-third less time than could have been done with the old equipment. By making this saving the railroad has been able to provide more steady and uniform shop employment. Under the present scale of operation, mileage is being put back into Great Western power faster than it is being run out.

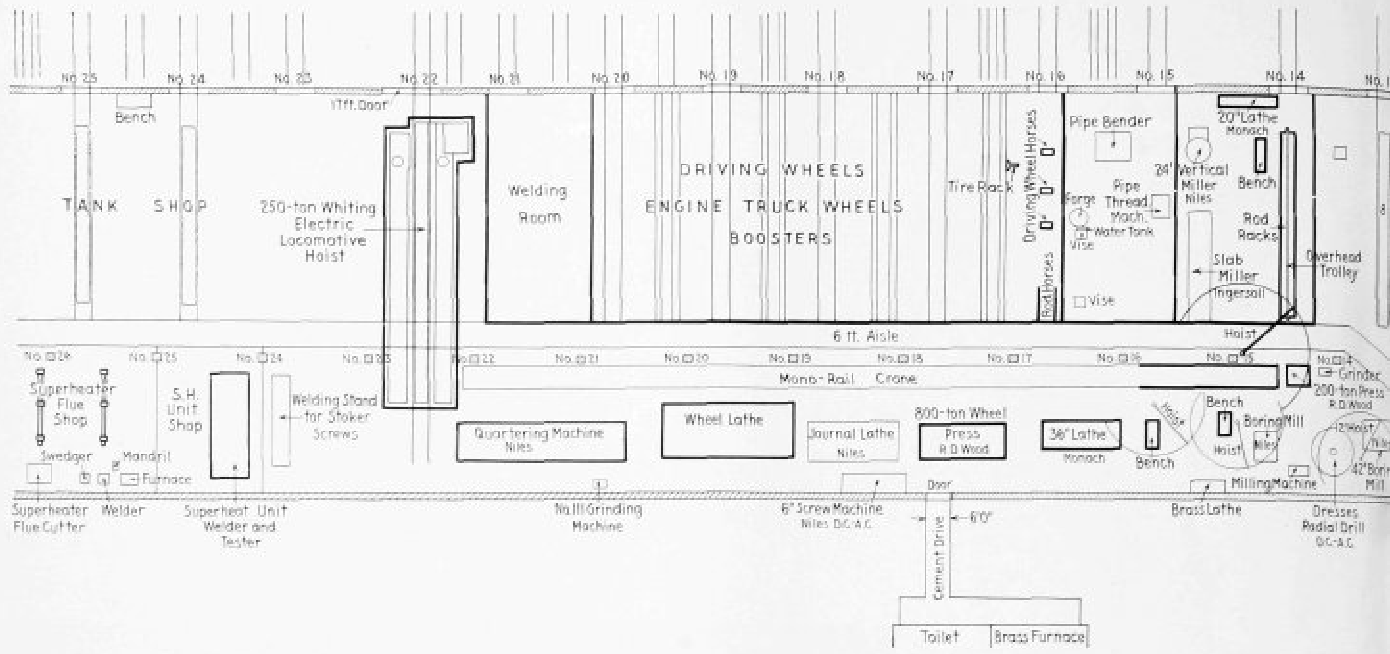
Referring to the drawing, the general method of operating the Oelwein locomotive repair shop is as follows: Locomotives are received on Pits 5 to 14, where the rods, brake rigging and piping are stripped. The locomotives are then taken to Pit 22 over the Whiting hoist, where the binders are dropped and the locomotives unwheeled; all wheels are pulled out with a cable in one operation. Dolly trucks are applied and the locomotive is moved back to the erecting pit, via the transfer table.



Pits filled in under fireboxes are a boon to the boiler maker



A 2-10-4 type locomotive on the Whiting 250-ton electric hoists at Oelwein shops



Floor plan showing the general arrangement of various facilities at Oelwein

Twenty Typical Machine Tools Retired at Oelwein Shops

Machine	Manufacturer	Date purchased	Age
Radial drill press	Niles Tool Works Company	1902	33
Quartering machine	Niles-Bement-Pond	1898	36
18-in. lathe	Lodge & Shipley	1901	34
20-in. by 10-ft. engine lathe	Fitchburg Machine Works	1887	48
25-in. planer	Niles Tool Works Company	1895	40
32-metal planer	Cincinnati Planer Company	1900	35
32-in. shaper	Morton Manufacturing Company	1913	22
96-in. 600-ton wheel press	Niles-Bement-Pond	1910	25
18-in. crank slotter	Betts Machine Company	1903	32
24-in. engine lathe	Schumacher & Boye	1910	25
30-in. engine lathe	Niles Tool Works Company	1898	36
36-in. vertical boring mill	Niles Tool Works Company	1902	33
No. 4 milling machine	R. K. LeBlond Machine Company	1913	22
Yankee grinder	Wilmarth & Morman	1910	25
Universal grinder	Brown & Sharpe	1904	31
22-in. lathe	Lodge & Shipley	1905	30
No. 3 universal milling machine	Hendey Machine Company	1902	33
36-in. vertical drill press	Niles Tool Works Company	1899	36
Turret lathe	Gisholt Machine Company	1905	30
Wheel lathe	Niles-Bement-Pond	1910	25

Average age—31½ years.

Machines Added at Oelwein Shops Since July 1, 1933

No. of machines	Type	Manufacturer
1	18-in. by 28-ft. lathe, second-hand	Monarch Machine Tool Company
1	24-in. by 14-ft. lathe, second-hand	Monarch Machine Tool Company
1	36-in. by 16-ft. lathe, second-hand	Monarch Machine Tool Company
1	Draw-cut shaper, 36-in. stroke	Morton Manufacturing Company
1	800-ton, 96-in. wheel press	R. D. Wood & Company
1	90-in. quartering machine, second-hand	Niles Tool Works Company
1	90-in. wheel lathe, second-hand	Niles Tool Works Company
1	Link grinder	Sundstrand Machine Tool Company
1	250-ton hoist	Whiting Corporation
1	30-in. slab grinder	Diamond Machine Company
1	20-in. by 96-in. gap grinder	Landis Machine Company, Inc.
1	Turret lathe	Warner & Swasey Company
1	No. 2 cutter grinder	Cincinnati Grinders, Inc.
1	No. 3 universal miller	Cincinnati Milling Machine Company
1	No. 5 plain miller	Cincinnati Milling Machine Company
1	200-ton rod bushing press	R. D. Wood & Company
1	100-ton rod bushing press	R. D. Wood & Company
1	20-in. by 48-in. lathe	Monarch Machine Tool Company
1	15-in. brass lathe	Bardons & Oliver
2	Sensitive drill presses	———
6	Electric motor lathe drives	Cullman Wheel Company

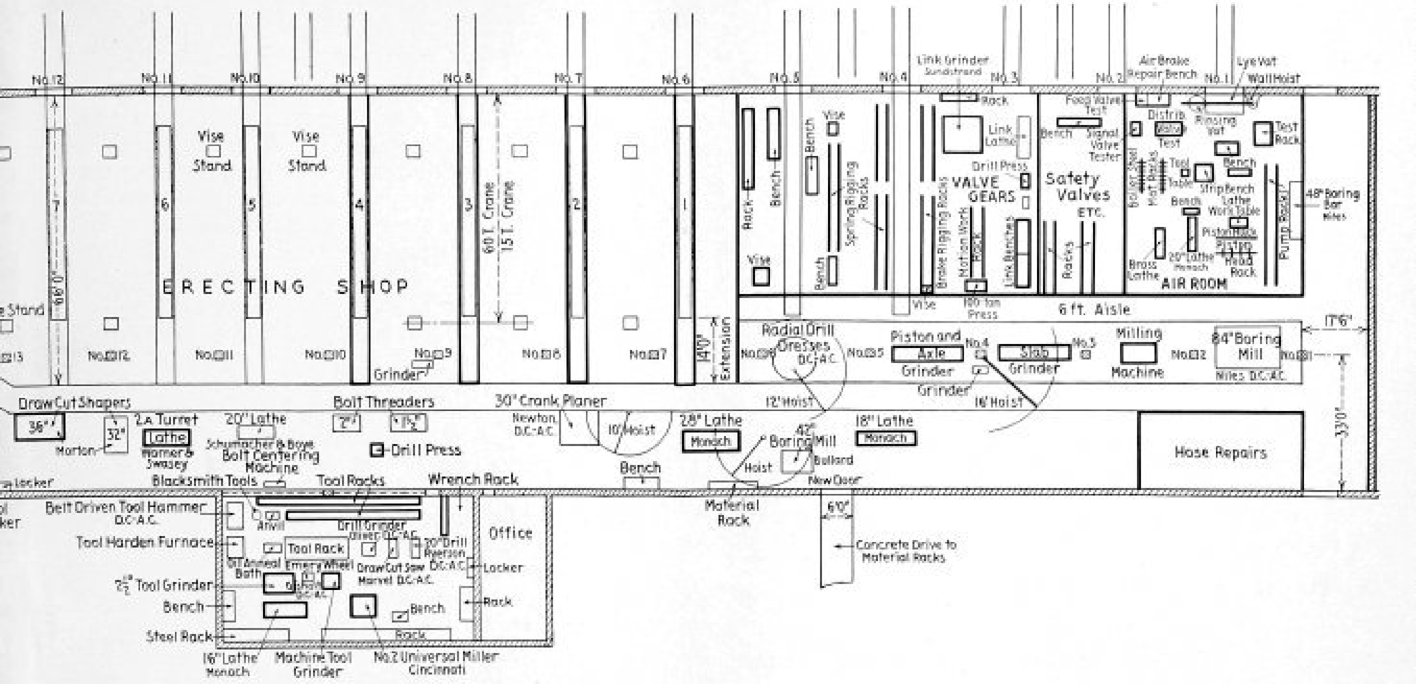
Wheels are sent to the wheel department and stripped after first being cleaned. Driving boxes are trucked to the cleaning vat and then to the driving box department where new brasses are applied. All driving boxes are built up to standard size. The box faces are planed on a 36-inch Morton draw-cut shaper, which also finishes the crown brasses.

Rods are sent to the cleaning department and returned to the rod bench for testing and finishing. In this connection, the special rail-type rod benches keep all rods off the floor, support them at a convenient height for working on them and an overhead traveling pneumatic hoist saves labor in handling. Piston valves and crossheads are cleaned and sent to the proper departments for necessary repair work on these parts. Air-brake parts are sent to the air-brake department which has its own cleaning vats. All air-brake valves are repaired and tested at this point.

Flues are removed from the boiler and loaded on flue trucks, each of which carries a complete set to the cleaner, from which the flues are moved to the flue shop for safe-ending, testing and cutting off. Superheater units are removed and taken to the superheater-unit position. In cases where extensive boiler work necessitates, the boilers are cut free from the frames and cylinders and moved by a 60-ton traveling crane into the

Machines Installed at Oelwein Enginehouse Since May 1, 1933

No. of machines	Type	Manufacturer
1	50-ton electric drop table	Whiting Corporation
1	90-in. wheel lathe	Niles Tool Works Company
2	Double-end grinders	Ransom Grinding Machine Company
1	4-in. radial drill	Dreses Machine Tool Company
1	Rockford drill	Rockford Machine Tool Company
1	24-in. vertical turret lathe	Bullard Company
1	36-in. crank shaper	Ohio Machine Tool Company
1	100-ton bushing press	Hydraulic Press Manufacturing Company
1	20-in. engine lathe	Sidney Machine Tool Company
1	Portable crank pin grinder	Micro Machine Company
1	36-in. by 16-ft. engine lathe	Betts-Bridgeford Company
1	2-in. bolt threader	Landis Machine Company, Inc.
2	Pit grinders	Ransom Grinding Machine Company
2	100-ton jacks	Duff-Norton Manufacturing Company
1	Electric crane truck	Baker-Raulang Company
1	18-ft. jib crane, 6-ton hoist	———
1	13-ft. jib crane, 2-ton hoist	———
1	18-ft. jib crane, 1-ton hoist	———



comotive shops—Heavy lines indicate the location of new machines

boiler shop. A 15-ton messenger crane is available for lighter movements underneath the main crane. Booster and stoker work is done in a department adjacent to the unwheeling pit. The stoker screws are built up with a combination of acetylene and electric welding to the original diameter and thickness. Acetylene is used in tack-welding and forming the new steel spiral strip applied to the outside edge of the screw and electric welding is used for completing the welding operation. This work is done in an engine lathe between centers with a gage to indicate the proper height and flight of each web.

Boiler Modifications in British Locomotive

By G. P. Blackall

Before the end of the current year the London Midland & Scottish Railway, Britain's largest railroad system, intends to put into service ten 4-6-2 type passenger tender locomotives generally modeled on the *Princess Royal* type. The first, named *Princess Margaret Rose,* is just ready for traffic. While these locomotives are described as being of the *Princess Royal* type, certain modifications have been made as the result of experience gained with their prototype. Interesting features of the new model just completed are herewith given.

The boiler has been designed to supply superheated steam at 250 pounds per square inch pressure. The barrel plates and firebox wrapper sheets are made of 2 percent nickel steel, and the barrel is tapered. The firebox is extended into the boiler barrel to form a chamber for the more complete combustion of the gases. This is a new feature as compared with the original boilers. The fire door is of the sliding type, and is equipped with a screen to protect the engineer's eyes from the glare of the fire. An exhaust steam injector with 12 millimeter cones is fitted on the right-hand side, and on the left, or driver's side, a live steam injector with 13 millimeter cones. Both injectors deliver to the boiler through top feed check valves. Sliding trays are fitted underneath the water delivery nozzles inside the boiler to permit periodic cleaning.

The superheater elements are of the bifurcated type from single downcomers, which are provided with spherical ball joints to the superheater header. The number of superheater flue tubes has been increased from sixteen to thirty-two. The regulator is incorporated with the superheater header casting inside the smokebox. The control for the main regulator is of the usual type, but to ensure easy manipulation the handle is balanced, and a small sight-feed lubricator in the cab, under the control of the driver, supplies lubricant to the regulator valve.

A steam manifold is provided on the top of the firebox door sheet in the cab, and carries valves for the following fittings; injectors, steam brake for locomotive and tender, car heating, pressure gage, sight feed lubricator to regulator, and whistle. The steam supply can be cut off by means of a single valve through which steam is supplied to the manifold. There are four pop type valves of 2½-inch diameter. Other boiler mountings, such as water gage frame and protectors, are of the railroad's standard type.

There are four cylinders, each 16¼ inches diameter by 28 inches stroke. The piston valves are of 8 inch diameter with a stroke of 7¼ inches, and they are actuated by Walschaert valve gear. Mechanical lubrication is provided for the cylinders. The feeds to the piston valve liners are taken through a steam atomizer. There are two feeds to each of the cylinders, one at the top of the barrel and one at the bottom, the lubricators being of the railroad's standard type.

These locomotives are being built at Crewe to the designs of W. A. Stanier, chief mechanical engineer of the railroad. The dimensions of the earlier and the new improved 4-6-2 four-cylinder locomotives are given at the top of the next page.

	Earlier Design	New Design
Four cylinder diameter by stroke	16¼ in. by 28 in.	16¼ in. by 28 in.
Valve gear, type	Walschaert	Walschaert
Valve gear travel	7¼ in.	7¼ in.
Boiler:		
Working pressure, pounds per square inch	250	250
Firebox heating surface, square feet	190	217
Tube heating surface, square feet	2,523	2,097
Superheater, square feet	370	623
Grate area	45	45
Tractive effort, pounds at 85 percent boiler pressure	40,300	40,300
Weight loaded: Locomotive	104½ long tons	104½ long tons
Weight loaded: Tender	54 tons 2 cwt.	54 tons 13 cwt.
Total	158 tons 12 cwt.	159 tons 3 cwt.

Work of the A. S. M. E. Boiler Code

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information on the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the council of The American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published.

Following are records of the interpretations of this committee formulated at the meeting of March 15, 1935, and approved by the council.

Case No. 798
(Interpretation of Par. H-81)

Inquiry: Par. H-81 of the Code refers to "unsupported joints" which are fusion-welded. Are the joints, when welded-in staybolts are attached to the plate as provided for in Par. H-83, considered "unsupported joints" as contemplated by Par. H-81, and do boilers fabricated in that way require shop inspection?

Reply: It is the opinion of the committee that where staybolts in heating boilers are attached solely by welding the intent of Par. H-81 requires inspection by an authorized inspector during construction.

Case No. 803
(Interpretation of Par. P-214)

Inquiry: Is it necessary, under the Code rules for staying of heads of firetube boilers, to apply stays to the segment of the head of an horizontal return tubular boiler when the maximum radial distance from the top row of the tubes to the shell, less the 2 inches exemption above the top row of tubes and less the exemption *d* next to the shell, does not exceed the allowable staybolt pitch of Table P-9 for the particular head thickness and working pressure?

Reply: Par. P-214 of the Code indicates the areas to be stayed when staying is required. The rules in Par. P-216 determine if staying is required.

Interpretations of Cases Nos. 780 (Reopened), and 804 Formulated at Meeting of the A.S.M.E. Boiler Code Committee Held May 24

Case No. 780 (Reopened) *(Special Rule)*

Inquiry: The use of the high-strength copper-alloy material covered in the inquiry in Case No. 715, which is allowed by the reply to that case a working stress of 9000 pounds per square inch, results in too great a weight for a seamless forged pressure vessel (annealed, if required to obtain specified properties) when computed at that stress for use for high-pressure purposes at very low temperatures. Will it be acceptable, under the code rules, to compute the working pressure of such seamless vessels fitted with bolted covers to operate in low-temperature service on the basis of a stress allowance of 11,000 pounds per square inch, provided that any openings in the cylindrical portion of the shell are adequately reinforced under the rules in Par. U-59? The material in such vessels will be the same as that referred to in Case No. 715 except that the elongation requirement is lowered to 50 percent and the reduction requirement to 60 percent. It is pointed out that the ultimate strength and the elastic limit of this material is considerably improved at low temperatures.

Reply: In view of the data submitted, it is the opinion of the committee that the material referred to, if used in seamless forged vessels fitted with bolted covers with all openings in the shell adequately reinforced, will give safe results at sub-zero temperatures under a working stress of 11,000 pounds per square inch.

Case No. 804 *(Special Rule)*

Inquiry: Is it permissible, under the requirements of the code, to fusion weld superheater tubes complying with Specifications S-17, up to a maximum diameter of 2½ inches to tubular manifolds or headers? The welds will be strength welds similar to Fig. P-7*c* and the tubes would not be expanded. The welding would be equivalent to that required under the rules in Pars. P-101 to P-111 and X-ray examination would be omitted. The elements would be stress-relieved after welding. Inquiry is also made whether, under these conditions, it would be necessary to hammer test such welds in accordance with Par. P-109, or would a hydrostatic test of twice the working pressure be sufficient?

Reply: It is the opinion of the committee that the rules for attaching nozzles by fusion welding as given in Par. P-268*b* may be used for attaching superheater tubes to tubular manifolds or headers. It is also the opinion of the committee that as the hammer test is not required for small nozzles it is not necessary to hammer test these welds. A hydrostatic test of twice the working pressure, subject to any necessary modifications due to temperature requirements in accordance with Table P-8, will meet code rules.

Air or Gas Compressor.—A steam-driven air or gas compressor, being produced by the Ingersoll-Rand Company, New York, is completely described in a well-illustrated catalogue. The XPV steam-driven compressor, as it is designated, is an entirely modern machine of so-called "four-corner" construction, which permits any arrangement of steam and air cylinders. It is of the horizontal, duplex, double-acting, double-crosshead and tie-rod type, built to run at moderate speeds and for heavy, continuous service. Sizes range from about 50 to 1500 horsepower with steam and compressor ends to meet practically any pressure conditions.

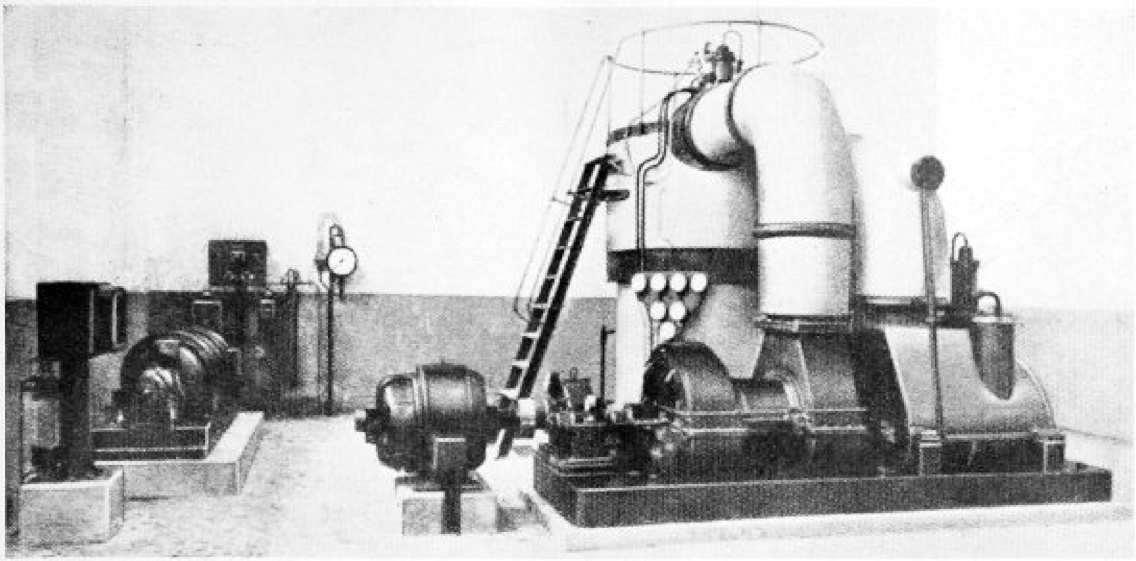


Fig. 1—Velox power plant with self-contained superheater

Possibilities on land and sea of the

VELOX STEAM GENERATOR*

***By Adolphe Meyer*†**

The principal aim in the development of steam generators during the last few years has been to design and manufacture larger units working at higher pressures and temperatures than in the past. Most firms have tried successfully to develop their own designs of this type of high-pressure boiler, but comparatively few of these designs have been departures from the well-known types of low-pressure boilers. While a few of these boilers incorporate new and interesting ideas in the production of steam and the regulation of combustion, nothing has been done to improve materially combustion itself or the rate of heat transmission. It is in relation to these last two points that the Velox boiler differs essentially from most boilers which have been in use up to now. Its name "Velox" refers to the high velocity of the flue gases, used to obtain exceptionally high heat transmission, as well as to the property of producing steam in a few minutes from cold and of adapting itself to widely varying loads in a few seconds.

The development of the Velox boiler is founded on studies and research work carried on some years ago in connection with the supercharging of Diesel engines and with the design of an oil turbine. Heat losses which occurred in cooling gas-turbine nozzles, in which the speed of the gases was far in excess of the velocity of sound, could only be explained by heat-transfer figures far above anything that could be expected by extrapolating the existing formulas of heat transfer to the prevailing conditions. There was then conceived the idea of using this feature, which in the gas turbine produced a heavy loss, to advantage by applying it to a steam generator.

Intensive research work with a small combustion chamber and a single tube in which velocities up to and exceeding the velocity of sound were produced gave very interesting results. The results showed that if such velocities could be economically obtained and applied to steam generators, the heat-transmitting surfaces could be reduced to about one-tenth of those of existing boilers with a corresponding saving in space and weight. The realization of such gas velocities does, of course, cause pressure drops far in excess of those occurring in ordinary boilers, and combustion under pressure in a tight combustion chamber had to be resorted to.

The question how to produce this pressure so economically as not to impair the efficiency of the new steam generator was first answered by the use of an explosion cycle for combustion and an exhaust-gas-driven turbo-blower, which had only to give about one-quarter of the final pressure obtained by the explosion of the fuel. It was therefore feasible to put the gas turbine at the end of the gas stream which goes from the combustion chamber through the evaporator, superheater, and preheater. Thus the gas arrived at the gas turbine with such a low temperature that it could be cooled down by the expansion in the gas turbine to a temperature below that of the surrounding air. As the power thus gained from the expanding exhaust gases is entirely recovered in the blower as heat put into the air, there is, at least theoretically, a possibility of getting more heat into the boiler than is supplied by the fuel. As this heat ratio greater than one had wrongly been termed an efficiency greater than 100 percent, a lengthy and rather heated discussion

* Abstract of the Second Calvin W. Rice Memorial Lecture, delivered at the Semi-Annual Meeting, Cincinnati, June 17-21, 1935, of The American Society of Mechanical Engineers.

† Brown, Boveri & Company, Baden, Switzerland.

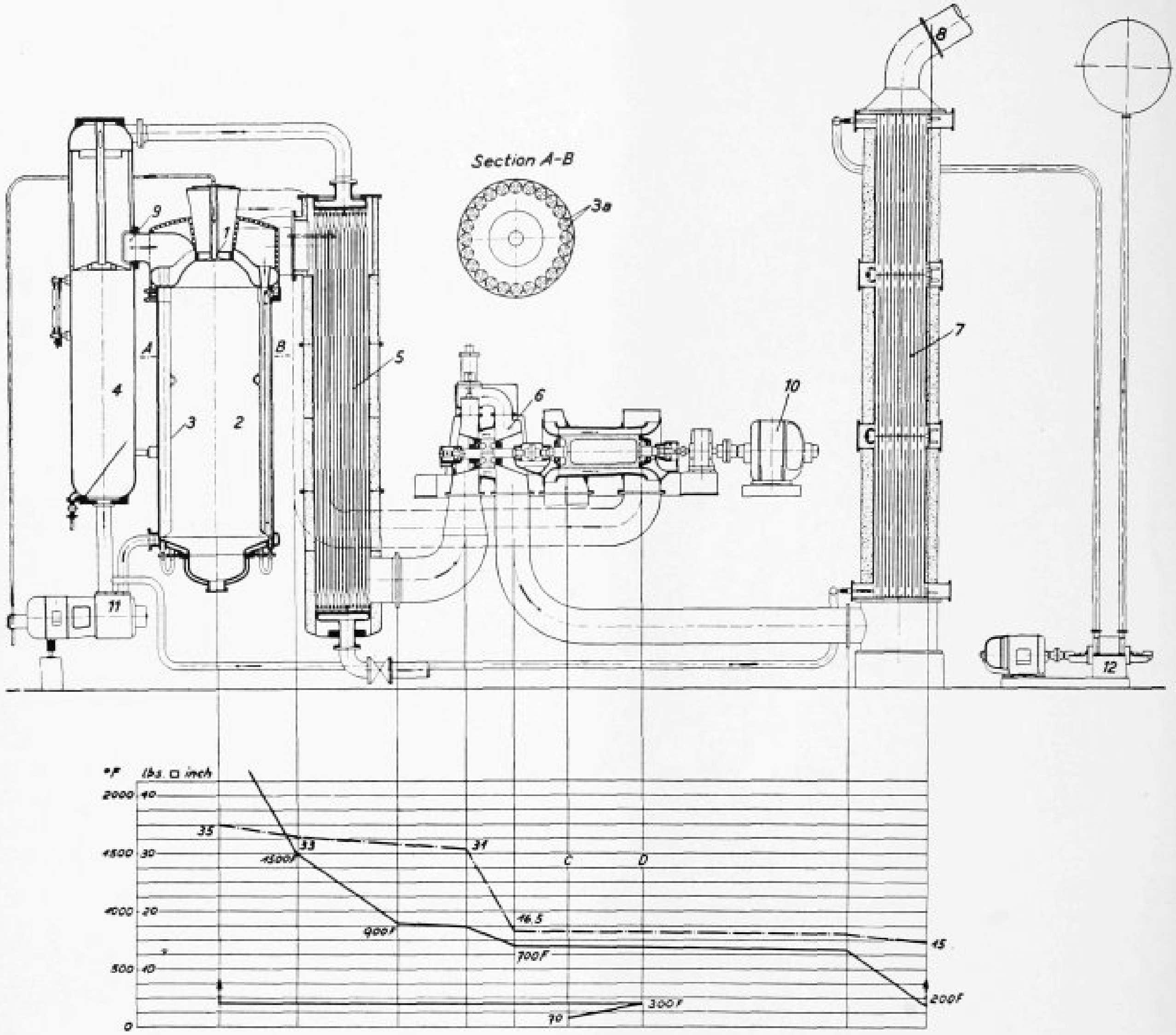


Fig. 2—Diagrammatic outline of Velox steam-generator, showing temperatures and pressures in various parts of the apparatus

took place in the leading British technical papers some time ago in which everything was said that can be said about this interesting problem.

Unfortunately the scheme did not work out well because of the purely practical difficulty of getting a uniform mixture of oil and air and a complete combustion in the combustion chamber of the 10-ton experimental boiler, the chamber of which was of enormous size as compared to the space in which combustion takes place in a Diesel or gas engine.

While the development of the explosion-cycle steam generator, which took the best part of three years, was going on the efficiency of the exhaust-gas turbine blower, developed for the introduction of the Buechi system for supercharging Diesel engines, had been so improved that it was possible to produce the full combustion pressure with the turbo-blowers and change over from explosion to continuous combustion. To this end, however, it was necessary to displace the gas turbine so that it would receive gases of sufficiently high temperature to enable it to produce the necessary power for driving the blower without the necessity of cooling the turbine. These conditions can be accomplished by placing the gas turbine between superheater and preheater in a zone of temperature around 930 degrees F.

Velox boilers, of which more than 20 units have been built in sizes ranging from 4 to 75 tons of steam per hour, for pressures up to 600 pounds per square inch and temperatures up to 850 degrees F., are all of the continuous-combustion type, and the following description as well as all further data given refer to this type.

Fig. 2 represents a steam generator of the Velox type, and indicates the temperatures and pressures prevailing in its different parts. The combustion of the fuel takes place in the combustion chamber *2* where air and fuel enter through the burner 1; the air at a pressure of about 35 pounds per square inch absolute and the fuel at about 300 pounds gage. The gases give up part of their heat content by radiation to the external walls of the evaporator tubes 3 which line the wall of the combustion chamber. More heat is transmitted by convection while the gases pass upward through the internal tubes *3a* of the evaporators to the exhaust flue-gas collecting chamber. Thus the initial temperature of combustion is reduced to about 1500 degrees F., while the pressure drops to about 33 pounds absolute. With this temperature and under this pressure the gases enter the superheater 5, to leave it cooled to about 900 degrees F., at a pressure of about 31 pounds. The gas turbine 6, which is then entered, causes the flue-gas temperature to drop to about 700 degrees F., while the pressure drops to about 16.5 pounds absolute. The corresponding heat drop, apart from small radiation and bearing losses, is entirely converted into mechanical energy and transmitted to the blower where it is reconverted into heat with a corresponding rise in the air temperature. Finally, the gases escape through the feed-water heater 7 which forms part of the chimney. From thence they continue, through the chimney itself, to the atmosphere, where they leave cooled to about 200 degrees F.

The water and steam circuit is as follows:

The make-up water is fed by the feed pump 12 through the preheater 7 to the separator 4, where it mixes with the evaporating water. This water is kept in continuous circulation by the circulating pump 11 which pumps it through the combustion chamber 2 and evaporating tubes 3 back to the separator 4 at the rate of about ten times the full-load evaporation.

The circulating pump gives the circulating water a sufficient pressure head to impart a high velocity to the steam and water mixture which is forced through nozzles into a vertical drum and the steam and water are thus separated by centrifugal action. The separating capacity of this centrifugal separator is about 100 to 200 times greater than that of the normal drum. The water then falls through a small gap in the lower partition of the separator, while the steam enters the superheater 5, where it is superheated to the desired amount for use in a steam turbine.

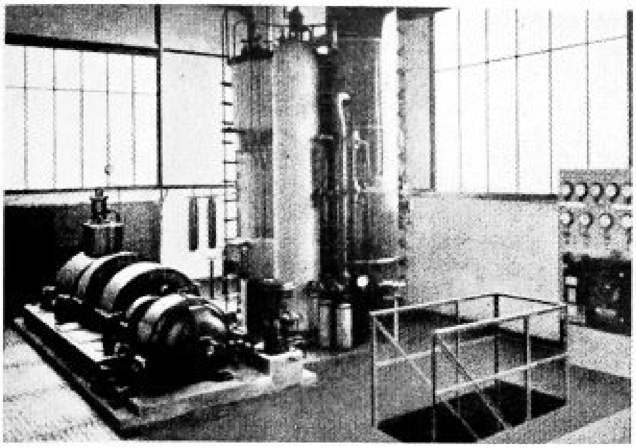


Fig. 4.—Velox boiler with external superheater, Toulon, France

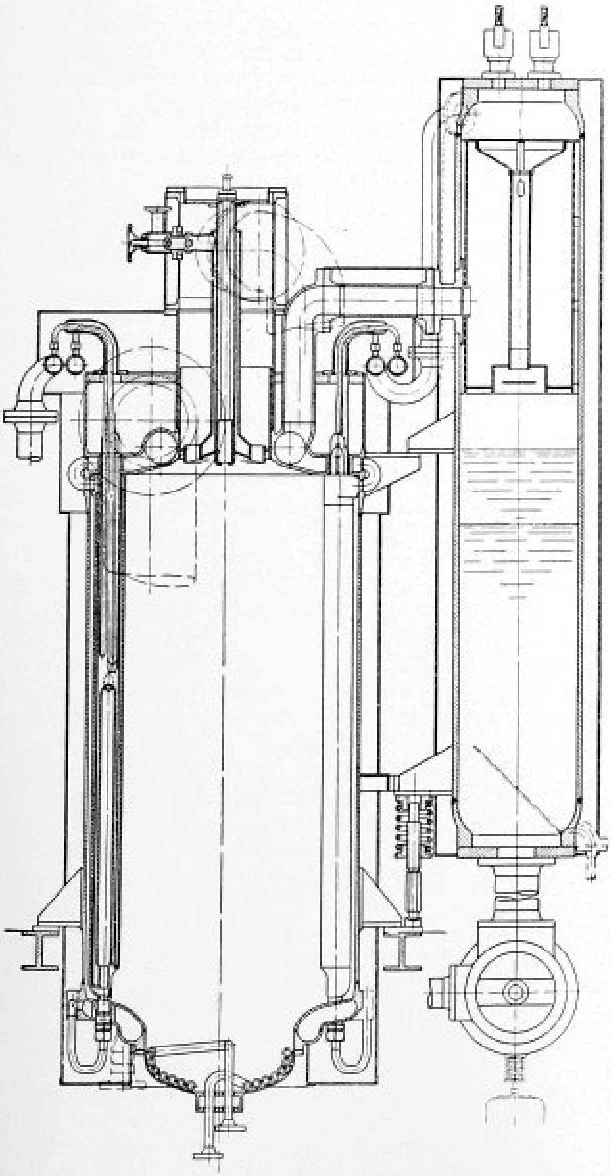


Fig. 3.—Section through Velox steam-generator with superheater tubes built into evaporator tubes and a burner for oil and gas firing

Apart from the scheme itself, certain new features will be of interest. The evaporator tubes lining the wall of the combustion chamber to protect it from radiant heat, shown in Fig. 3, are bolted to the wall at the outlet end and are guided so as to expand freely on the inlet end. Thus they can be removed from the chamber with ease. The inner tubes, which have nozzle-shaped inlets, show a remarkable diffusing action. They tend to re-transform kinetic energy into pressure, due to rapid cooling of the passing gases with a corresponding reduction in volume. The flue gases pass the superheater elements in a longitudinal direction, the tube heads being streamlined so as to reduce pressure losses.

In the most recent design the superheater elements are placed inside the evaporator tubes and therefore inside the combustion chamber. This gives a very compact and neat design as shown in Fig. 3.

As previously mentioned, the overall efficiency of the supercharging set is of great importance. For the first boiler an impulse-turbine-driven blower was used, similar to those used for supercharging Diesel engines. The boilers are now fitted with reaction turbines having three to four stages and axial blowers which have been specially developed for this purpose. The overall efficiency is of the order of 83 (turbine) $\times$ 73 (blower) $=$ 60 percent.

With a view to reduction in weight, the gas-turbine casing is entirely welded, while the blower casing is built up of a blade-carrying cast-iron body and welded air chambers. Both machines have heavy shafts so as to run below the critical speed. As their speed varies proportionately with the load, they must be able to run continuously at any given speed between no load and full load.

The gases flow along the tubes of the preheater in the same manner as they do in the superheater.

Owing to the small amount of material taking part in heat transmission and to the small water-storage capacity, which has been purposely kept down to a minimum, the boiler can be set to work in an unusually short space of time.

Higher Efficiency. With oil firing and for stationary and merchant-marine boilers the thermal efficiency, that is, the degree of heat utilization, amounts to 94 to 96 percent. The plant efficiency, including all auxiliary machinery except the boiler feed pumps, is 90 to 93 percent. For gases of poor quality or for naval and locomotive boilers, which, on account of further reduction in weight have smaller preheaters, the efficiency is 2 to 3 percent lower. The efficiencies remain practically constant from one-fourth to full load. All efficiency figures are based on the lower calorific value of the fuel.

Immediate Automatic Adaptation of the Firing and Feed Water to Suit Steam Requirements. Depending upon the kind and size of the auxiliary and governing motor, in the short time between 12 and 40 seconds the load can be increased from one-fourth to full load without any appreciable pressure drop and unloading can occur over the same range without blowing the safety valve.

Rapid Starting. As a result of the small masses involved, the absence of refractory brickwork, and the positive supply of fuel and combustion air, the Velox boiler can be brought from a cold condition up to full load in 4 to 8 minutes, depending upon the size and loading capacity of the auxiliary motor.

Small Space Requirements. The necessary floor space, including adequate room for operating and erecting purposes, required for example, for a boiler rating of 20 tons per hour is about 27 square feet per ton; for 50 tons per hour, 16 square feet per ton; and for boilers for warships, e.g., 60 tons per hour, 5 square feet per ton.

The most important advantage of the small amount of space required is the possibility of a compact arrangement of boiler and prime mover, whereby steam lines, pipe fittings, and other accessories can be dispensed with, the whole installation being simplified and the boiler house completely eliminated.

Small Weight. The weight of the complete boiler plant, including all auxiliary machinery, depending upon the output, is for land installations 1.2 to 2 pounds per 1000 pounds of steam, for cargo vessels and locomotives 1.0 to 1.8 pounds per 1000 pounds of steam, and for warships and "small boilers" 0.6 to 1.2 pounds per 1000 pounds of steam.

Rapid Erection on Site. The boiler can be completely erected and tested in the shops of the manufacturer so that erection on the site takes only a short time. It requires little foundation and no brickwork. Due to the comparatively high exhaust-gas velocities which are admissible, it is possible to keep exhaust-gas piping and flues small.

The aforementioned features and advantages of the Velox steam generator make it attractive for a number of applications on land and sea.

Power Stations and Industrial Services

For power stations and industrial services in places where gaseous or liquid fuel can be obtained cheaply the Velox boiler has attractive possibilities. When comparing fuel costs, however, it must be considered that the Velox boiler has a higher efficiency than other boilers (especially those that are coal-fired) and the possibilities of governing and rapid starting which it offers almost completely eliminate the losses resulting from partial loading and stand-by periods.

The initial cost of the power station will be considerably lower than that of one with ordinary boilers because of reduced costs for the building, foundations, cranes, and piping.

The Velox boiler offers above all the possibility of a revolutionary change in regard to power-station construction. Boilers and turbines need not be two independent units separated from each other in regard to space and their attendance and operation, but can be united in one organic whole.

Iron and Steel Works

In steel works the Velox boiler with steam turbine may be used as a substitute for gas engines. A gas-engine plant with six engines of 3500 kilowatts each and two 5000-kilowatt waste-heat turbo-generators, i.e., 31,000 kilowatts total, can be replaced by two Velox steam generators and a steam turbine of 30,000 kilowatts output, which take the same space as that occupied by one of the gas engines. Such a steam plant can, owing to its high efficiency at all loads, advantageously compete with the gas engine with steam pressures around 600 pounds and temperatures of 800 degrees F. The dust content of the gas used for Velox steam generators can be the same as, or slightly higher than, that of the gas used for gas engines.

Central Heating Plants

The small space requirements, high economy, rapid starting, and quick regulation, but above all the cleanliness, quietness, and freedom from smoke, make the Velox boiler suitable for heating plants. The plant becomes especially simple when used for producing hot water, as in this case the steam separator and superheater can be dispensed with.

Such plants have been supplied for the University Centers of Madrid and Rome, for the Swiss Federal Institute of Technology in Zurich, and for the State Hospital in Aarau, Switzerland, with a total of six boilers. In three of the four plants the Velox steam generator runs in parallel with coal-fired or electric boilers, being especially used for peaks and small loads.

Merchant Vessels

The most important field of application for the Velox boiler is doubtlessly the ship. The small space requirements of this boiler and its low weight and high efficiency are of most value here, and the fact that it is essentially an oil-burning boiler is no drawback in most cases. In comparison with the Diesel engine the Velox steam generator has the advantage that every kind of oil can be used and there is no restriction as to the use of the more expensive gas and Diesel oils. The fuel consumption of the Diesel engine is, of course, lower than that of a Velox steam-turbine installation. The difference in price between Diesel oil and bunker oil is, in many countries, greater than the difference in fuel consumption, so that the fuel costs for a Velox are generally lower than those for Diesel engines. The Velox steam-turbine plant is also more favorable in regard to weight, except for long voyages where the excess fuel oil equalizes the weights in about 40 days steaming. The weight of a Velox steam generator is on an average one-fifth that of the ordinary oil-fired water-tube boiler, and its space requirements, even compared with the most modern marine boilers, are less than half. Of great importance are its small height and the smaller dimensions of the flues and funnels.

With existing plants having a larger number of boilers it is generally possible to replace one existing boiler by a Velox which takes the output of all the other boilers. By means of such a substitution the power range and economy of old ships can be considerably increased, and even more so if at the same time the steam pressure and superheat are increased and the additional heat drop is used in a supplementary high-pressure turbine which may drive through existing gear. In new ships the Velox enables a more favorable arrangement of machinery, higher power, and more loading space for cargo and fuel to be obtained.

Warships

In warships of ordinary design the full steam output is obtained by forcing the boilers to about three to four times the amount which such a boiler would normally give if otherwise applied. The efficiency of such boilers, therefore, decreases when the load increases with increasing exhaust temperature of the flue gas. The difference in weight and space requirements of the Velox boiler, when compared with such forced boilers, is thus not so considerable as is the case when compared with boilers which have to operate at highest efficiency. However, the weight and space requirements of the Velox boiler, as developed for warships, remain considerably below those of the lightest type of marine boiler.

The weight of a complete boiler plant for a warship of smaller size is under 1 pound per pound of maximum steam production. Steam generators for 60 tons of steam per hour and more weigh, including water and oil for lubrication and governing, less than 0.8 pound per pound of steam per hour.

The small space requirement enables two Velox boilers of 60 to 75 tons per hour each to be accommodated in a standard torpedo-boat profile of 23 to 26 feet width and 18 feet in height between two bulkheads 23 feet apart. In submarines, the small masses, the possibility of rapid cooling by running cold air through the boiler, and the small dimensions of the exhaust pipes enable the time required to prepare for submerging to be reduced to an extent hitherto only to be obtained with Diesel engines.

A fundamental difference between the Velox boiler and navy boilers is that full load can be maintained continuously for any length of time with the same high efficiency as on part load. This efficiency amounts to between 88 and 90 percent, compared with 75 percent or less obtained with a forced ordinary boiler. The Velox boiler operates entirely automatically, the exhaust gas is completely invisible even at maximum output and has a low temperature. When steam is available from one boiler only, supplementary boilers can be brought from cold up to full load in less than five minutes.

By taking full advantage of the technical means offered by the Velox boiler, war vessels of hitherto unforeseen striking power may be built.

For obvious reasons no information about Velox plants in warships is available except the fact published in British papers, that one unit is built for the British Navy by Yarrow and Richardsons Westgarth, the former building the boiler proper, the latter the gas turbo-blower and other auxiliaries.

Locomotives

Space requirement, weight, and efficiency are also of paramount importance for locomotives. The wheelbase, axle loading, and gage determine the dimensions of the boiler, and for the ordinary locomotive boiler the maximum output is thus fixed. By means of the Velox boiler the output can be considerably increased. Due to its small weight the weight of the locomotive need not be greater than is essential in order to maintain the necessary adhesion, so that all superfluous running wheels can be dispensed with. The small amount of space required enables the boiler and the auxiliary devices to be easily accommodated in the chassis in such a way that adequate room is left over for driving and attendance. The driver's cab, for instance, can be situated in front and the entire locomotive mounted in a streamlined body. The automatic governing of the boiler simplifies the attendance and the rapid steam production and adaptability to varying loads enable much shorter starting times and more rapid acceleration to be obtained than is the case with the ordinary locomotive boiler. By substituting a Velox generator for an ordinary locomotive boiler on an existing locomotive it is possible to obtain higher speeds and greater running ranges without altering the driving mechanism. A transformation of an existing locomotive to 2400 horsepower and 100 miles per hour has been ordered.

The Velox can also be advantageously used on rail cars and is especially favorable in competition with Diesel rail cars. For smaller powers (up to 1000 horsepower) the plant is equipped with air-cooled condensers.

Recognition Given Flame-Cut Edges

One of the most significant recognitions that the oxy-acetylene process has received recently is in the latest revisions proposed by the Boiler Code Committee of the American Society of Mechanical Engineers for the A.S.M.E. Boiler Code.

These changes provide for the use of oxy-acetylene flame-cutting for the preparation of steel plate edges in steel of up to 0.35 carbon content for boiler and pressure vessel fabrication. Provision is made that the edges be uniform, smooth, and freed of all loose scale and slag accumulations before welding. The discoloration which may remain on the flame-cut surface is not considered to be detrimental oxidation.

This action of the A.S.M.E. comes as a logical conclusion to the research that has been carried on in several quarters during recent years. This research, representing a vast amount of work, has resulted in determining definitely that the preparation of low-carbon steel edges by flame-cutting without subsequent finishing leaves a finished edge of steel that is in no way detrimental to further fabrication of the plate or shape.

Among the authoritative papers on the results of these investigations have been: "The Advantages of Flame Cut Surfaces for Welding," by C. W. Obert, presented before the 35th Annual Convention of the International Acetylene Association; "Flame Cutting of Structural Steel," by S. W. Miller and J. R. Dawson; "Tests on Structural Details Flame-Cut from I-Beams," a summary of tests by the Bureau of Standards, and "A Comparative Study of Cutting Methods as Applied to Structural Steel," by Professor J. H. Zimmerman, Massachusetts Institute of Technology, presented before the 35th Annual Convention of the International Acetylene Association.

It is recognized, of course, that the findings of the Boiler Code Committee of the A.S.M.E., based on these and other investigations and as proposed for revision of the Boiler Code, apply specifically to the use of flame-cut edges in boiler and pressure vessel fabrication. Since this particular work, however, comes under perhaps the most rigid control of any type of manufacturing, official acceptance of flame-cutting in this case indicates its acceptability for any type of edge preparation, be it for boilers, structural steel, or the fabrication of machinery parts and structures.—*Oxy-Acetylene Tips.*

Formulation of Joint API-ASME Code for Pressure Vessels*

By Dr. D. S. Jacobus†

I have been asked to say something about the comparatively new Joint American Petroleum Institute-American Society of Mechanical Engineers Code and the Boiler Code of the A.S.M.E. which embraces unfired pressure vessels as well as boilers.

The A.S.M.E. Unfired Pressure Vessel Code gives rules for the construction of unfired pressure vessels and contains no rules for the inspection of such vessels, nor does it give rules to cover the withdrawal of the vessels from service should they become deteriorated through corrosion or in any other way. These features are left entirely in the hands of the state and city inspectors in charge of the enforcement of the code. That the provisions of the A.S.M.E. Unfired Pressure Vessel Code, combined with the care taken by the inspectors, have given good results can be appreciated on considering the fact that there has been no explosion reported to the Boiler Code Committee of an unfired pressure vessel built under the code.

There have been a number of cases where the vessels have corroded through without exploding, these being for vessels constructed under Par. U-70 of the code, where the prescribed working stresses, particularly for the thinner walled tanks, are lower than for vessels constructed under Pars. U-68 and U-69 for other conditions of service. The vessels constructed under Par. U-70 are for tanks such as air tanks used in garages and for a number of other conditions of service where the fact that they will corrode through in spots before exploding is a most important safety element. Little could be saved in the way of expense by building these tanks with thinner shells and it would therefore seem that the present practice for such tanks should not be departed from. That the tanks in question must be given every consideration in considering the safety features of the code can be appreciated on considering the fact that there were a number of accidents and fatalities through the bursting of tanks of the sort that were built prior to the adoption of the code and that it has been estimated that about 90 percent by number of the tanks constructed by fusion welding fall in this class.

In order to consider the bearing of the Joint API-ASME Code on the A.S.M.E. Unfired Pressure Vessel Code it will be well to review the conditions which led to the formulation of this code.

The American Petroleum Institute has co-operated with the Boiler Code Committee for many years. The petroleum people took the position that their peculiar conditions were so different from those found in the general field as covered by the A.S.M.E. Unfired Pressure Vessel Code that they should be exempted from the provisions of the A.S.M.E. Code. The exemptions that have appeared in the A.S.M.E. Unfired Pressure Vessel Code have all been decided on only after conferring with the American Petroleum Institute. The Boiler Code Committee volunteered to join in preparing a section bearing on vessels for the petroleum industry whenever called upon to do so. The Joint API-ASME Committee was appointed by the American Petroleum Institute and the American Society of Mechanical Engineers in order that rules might be prepared for the part exempted in the A.S.M.E. Unfired Pressure Vessel Code. It was at first proposed to prepare a code for vessels to be used in the petroleum industry under the American Standards Association, but it was later decided to form the Joint API-ASME Committee. The rules which have been prepared are on a different basis than those in the A.S.M.E. Boiler and Unfired Pressure Vessel Code, as they include a system of inspection of the vessels to be followed after they are placed in service. The Joint API-ASME Committee has issued a statement to the effect that the code which it prepared should be used as a whole and that vessels constructed in accordance with the Construction Section should be regularly inspected in accordance with the Inspection Section.

The different bases on which the A.S.M.E. and the Joint API-ASME Unfired Pressure Vessel Codes are prepared make it impossible to compare the so-called factors of safety of the two codes directly with each other, as in the case of the A.S.M.E. Code it is a construction factor and in the case of the Joint API-ASME Code it is an operating factor. The A.S.M.E. Locomotive Code contains a provision that locomotive boilers shall not be operated at a lower factor of safety than 4, which is the same as that prescribed by the Interstate Commerce Commission. Should the Boiler Code Committee be called on to specify a minimum operating factor in its various codes, it would in all probability set the minimum operating factor of 4 and in this way make its codes compare more closely to the Joint API-ASME Code.

Factors of safety should not, however, be compared without considering the way in which they are computed. To illustrate this feature, consider the factor of safety of 5 for the construction of fusion welded vessels given in the A.S.M.E. Unfired Pressure Vessel Code. In computing this factor no account is taken of the falling off of strength of the steel in the shell due to the stress relief treatment, which may amount to about 10 percent. On considering this feature the factor would be reduced to about 4½ percent. In the case of the API-ASME Code, the factor takes into account the falling off of strength due to the heat treatment as the specimens of the plate to be used in the drum must be given a similar heat treatment to that to which the drum will be subjected before making the tensile tests. The factor of safety of 5 given in the A.S.M.E. Code would, therefore, correspond to a factor of safety of about 4½ on the basis used in the Joint API-ASME Code.

There are other elements that must be considered in comparing factors of safety which are the provisions for preventing excess pressure in the drum through the use of safety valves or other appliances. The joint effi-

* Address before the tenth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors, Chicago, May 14-17.

† Advisory engineer, the Babcock & Wilcox Company, New York; past president of the American Welding Society.

ciency must also be considered in comparing the factors of safety. The highest efficiency allowed for a fusion welded joint in the A.S.M.E. Code is 90 percent, whereas it is 95 percent in the Joint API-ASME Code. The rules for reinforcing openings are also different, those in the Joint API-ASME Code calling for heavier reinforcements than those in the A.S.M.E. Code for openings less than 20 inches in diameter, and for lighter reinforcements for openings over 20 inches diameter. All of these features should be rationalized.

All will agree that there should not be differences such as the requirements for reinforcements and the allowable joint efficiencies, and a Special Committee has been appointed to revise Section VIII of the A.S.M.E. Boiler Code, at which time these differences will be considered. Many have pointed out the advantages that would be secured if a single construction code could be agreed upon and it is hoped that this will eventually be accomplished.

The strength of the Boiler Code has come through its rigid enforcement in which the National Board of Boiler and Pressure Vessel Inspectors has taken a most important part in securing concerted action between the administrative departments of the states and cities. No similar means are so far provided for enforcing the Joint API-ASME Code and in this respect it lacks one of the most important elements of safety of the Boiler Code.

Expansion of the National Board of Boiler and Pressure Vessel Inspectors*

By C. O. Myers†

The subject assigned to me, "Visions of the expansion of the National Board," might lead some to believe that we are looking forward to expanding the activities of the National Board into fields other than those which are created by a demand to bring about a better understanding between the states and cities in the administration of a uniform Boiler Code of Rules. Our visions of today are the same as they were of yesteryear, that is, gradually expanding the objects of the National Board so that we, through co-operation with one another, can be of better service to all those who are affected by boiler inspection laws, and our ambitions for further expansion of the National Board will be confined to developing the objects set forth in the constitution and by-laws of the board, namely:

To secure uniform approval of specific designs of boilers and other pressure vessels as well as appurtenances and devices used in connection with their safe operation.

To promote one uniform code of rules, and one standard stamp to be placed upon all boilers constructed in accordance with the requirements of that code, and one standard of qualifications and examinations for inspectors who are to enforce the requirements of said code.

To compile official statistics and other data.

At the time the Constitution was written and adopted, in 1921, it seemed like an almost insurmountable task to bring about the objectives set forth as the purpose of the organization. The A.S.M.E. Boiler Code was in effect and adopted by all the states and cities who are members of the National Board, and the Code Committee had no authority to approve or disapprove the specific designs of boilers and pressure vessels as well as appurtenances and devices used in connection with their safe operation; neither did this committee have the authority to promote uniform standards of qualifications and examinations for inspectors who are to enforce the requirements of the code. Such authority rests entirely upon the officials of the various states and cities.

Before it was possible to secure a uniform stamping that could be acceptable, it was necessary to work out a system and put it into effect that uniformly qualified the shop inspector, who is responsible for the application of the uniform construction rules. If this inspector is not thoroughly familiar with the code, we can not expect to get code compliance. This means that to build up a system to bring about uniform stamping of boilers that will have the confidence of all the states and cities, we must have qualifications for inspectors of the highest standard. This is the basis upon which we have been laying the foundation for the uniform stamping, and we can feel confident that when a boiler is stamped "National Board," that it complies with the code in every respect. In making this statement I have not overlooked the fact that the National Board inspectors are human, and we have had a few cases where the inspector was somewhat negligent, but these are rare, and we have a provision to protect ourselves against too frequent negligence of an inspector by the revocation of his National Board commission.

In accomplishing some of the objects of the National Board, particular care has been taken not to involve states rights which are supreme, and everything that has been done has been through the voluntary co-operation of state and city representatives, and through such co-operation no state or city has been called upon to delegate its power and authority to an organization beyond the control of their laws or ordinances. Each state and city retains its individual rights in the by-laws of the National Board in the selection of persons who are qualified to obtain National Board commissions. Such commissions only authorize an inspector to make shop inspections and stamp the boilers, "National Board." No state or city need hesitate to accept a person who holds a National Board commission as a direct representative authorized to make field inspections as well as shop inspections. We have a condition in some few states and I will confess that Ohio is one of them, where some changes will need to be made before a person holding a

* Abstract of address before the tenth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors, Chicago, May 14-17.

† Chief of Division, Department of Industrial Relations, Division of Boiler Inspection, State of Ohio, and secretary of National Board, Columbus, O.

National Board commission can be accepted to make field inspections.

The National Board system of qualifying persons for commissions provides for a uniform examination. This uniform examination is now being held by all of the states, whose laws provide for a written examination. There is no real basic logic in requiring a person that has taken a National Board examination in some state and has been issued a National Board commission, authorizing him to make shop inspections, that when he is transferred to another state he should submit himself again to another written examination, which is prepared upon the same basis as the examination he originally took. In other words, nothing can be gained by qualifying a man more than once, unless it might be that he was not following the profession for a number of years. We are working toward the end of having persons holding National Board commissions acceptable for field inspections as well as shop inspections.

The National Board stamping for boilers is well established, and is being taken advantage of by practically all the boiler manufacturers who build code boilers. A complete record is kept at the office of the secretary-treasurer of every boiler that is stamped in this manner, and the information contained in these records is readily available for identification and checking purposes, and can be taken advantage of by any one who is interested. We have a system similar to the stamping of boilers in effect, for the stamping of unfired pressure vessels with the approved National Board stamping. There are some manufacturers taking advantage of this stamping, but they are only doing so when they are called upon to furnish a vessel in a code state that insists upon a National Board stamping. More thought should be given toward developing this phase of our work to bring about a more complete registration of unfired pressure vessels. This can be done if the states and cities that have laws governing the construction and installation of such vessels require that they be stamped National Board.

We have not obtained the height of our desires with respect to the approval of specific designs of boilers and appurtenances used for their safe operation. An effort is made to obtain the approval or disapproval by the members of the National Board of specific designs of boilers and appurtenances by correspondence. We appreciate the fact that this is not a very satisfactory method. However, it is the best that we can do under the circumstances, as our finances will not permit us to install a system whereby we could have committee meetings of at least three to meet at intervals of three months to take up these questions, and give them the necessary study and conduct laboratory tests to determine the merit of the device submitted, so that members of this board can be intelligently advised. It is our hope that some day our finances will be such that we can render this service to the industry as well as to the members of this board.

The question of gathering statistics of accidents to boilers and pressure vessels of all kinds has been discussed at several of our meetings in the past. A record of all boiler and pressure vessel failures, if such a record is accurate, will give the necessary information properly to guide the preparation of construction rules. It will give us some idea of the effect of a boiler inspection law. It would give us the necessary information to go before the legislatures of non-code states and enlighten them with just what is happening to pressure vessels that are operated without any regulations. Our statistician has made an honest effort to secure the necessary information of boiler and pressure vessel failures and prepare an intelligent report that would give a better idea of what was happening to code and non-code vessels in states that have boiler laws, and in states that do not have boiler laws. To secure authentic information necessary for a statistical report, it is necessary to have the full co-operation of the members of this board, the insurance companies, and all insurance company inspectors as well. This is one of the objects of the National Board that requires an outlay of money from which there is no income derived, and until we reach a position when our receipts will justify an expenditure to obtain statistics that will be of some value, nothing can be done to develop this most important work.

Within the last ten or fifteen years, boiler manufacturers have been called upon to build boilers for higher pressures and temperatures for the more economic generation of steam. With this demand for higher pressures and temperatures, a crop of new problems has confronted the States and the A.S.M.E. Boiler Code Committee in the preparation of rules governing their construction, so that such vessels may be safely operated. Due to this condition and to the advancement of more economic methods of construction, the Boiler Code of Rules has increased in size, and has become more complicated. It is a very difficult problem for the members of the National Board and the inspectors to keep in step with these constant necessary revisions and interpretations. The members of this board, by virtue of their office as chief inspectors of boilers administering a law under the A.S.M.E. Boiler Code are members of the conference committee of the Boiler Code Committee. Through this contact they are kept informed of all revisions and interpretations of the code. The chief inspector of boilers is held responsible by law for the proper administration of boiler rules for the protection of life and property. To keep in touch with the general conditions of the boilers that are in operation and to enforce the rules governing their construction, he commissions qualified persons to represent the state or city as an inspector of boilers, and to obtain proper code compliance the inspector must have a thorough knowledge of code requirements. While he is expected to be efficient in his duties as a boiler inspector, no means is in effect to keep him informed of revisions and interpretations of the A.S.M.E. Boiler Code Committee. Some system should be put into effect to advise all National Board inspectors of changes in the rules.

The chief inspector of boilers is also responsible for designs meeting code requirements and I do not believe that it is fair to the inspector to shift this responsibility upon him. The question of keeping the inspector properly informed of code changes and relieving him of the responsibility of designs meeting code requirements, should be given serious thought by all interested parties. These problems affect the more economic administration of boiler inspection laws, and we should have the full open-minded co-operation of the boiler manufacturers and insurance companies and nothing need be contained in the solution of these problems that could be considered as retarding the industry.

Westinghouse Motors for Republic Mill

The motor and control equipment for a new 42-inch reversible cold strip mill of the Republic Steel Company at Warren, O., has been awarded to the Westinghouse Electric & Manufacturing Company. Amounting to approximately $100,000, the order includes a 1200 horsepower mill motor and two 300 horsepower reel motors.

High-pressure tank built by arc welding for the storage of propane gas

Propane Tank Built of High-Tensile Steel

Three thousand six hundred cubic feet is a lot of propane gas to store at 200 pounds per square inch pressure!

Forty-one tons of a new steel, which has a tensile strength of 70,000 to 82,000 pounds per square inch, were used recently in fabricating a propane tank of this capacity at the plant of The Biggs Boiler Works Company, Akron, O. This tank, 67 feet long by 8 feet 10 inches diameter, was built by the shielded-arc process of welding in accordance with requirements of the A. S. M. E. Code for unfired welded pressure vessel construction. According to the manufacturer, arc welding was used to insure leak-proof construction.

The steel used in constructing this tank is a special high-tensile carbon steel developed for pressure vessels. It is made 2 inches and under in thickness. The analysis of the steel shows 0.32 carbon, maximum, for plate ¾ inch and less in thickness, and 0.35 carbon, maximum, for thicknesses over ¾ inch; 0.90 manganese; 0.035 to 0.04 phosphorus; 0.04 to 0.05 sulphur; and 0.25 silicon. The yield point, minimum, is one half the tensile strength.

All seams of the tank were butt welded under the special procedure control developed by the builder. The large heads are one piece construction 1$\frac{5}{16}$ inches thick.

This tank, shown in the accompanying illustration, operates at a working pressure of 200 pounds per square inch and passed a hydrostatic pressure and hammer test of 400 pounds. It was inspected and stamped for Code requirements by the Hartford Steam Boiler Inspection and Insurance Company. The high-tensile strength necessary in welding this steel was provided by use of shielded-arc welding equipment supplied by The Lincoln Electric Company, Cleveland.

Power Boiler Explosions*

Four men lost their lives as the result of a sawmill boiler explosion at Woodman, Ky., on January 2, 1935. A crack in a lap seam of a locomotive firebox type boiler opened up with force sufficient to blow the boiler over a slab pile 20 feet high. A steam engine nearby was demolished. The men, who were eating their lunch near the boiler, were hurled from 30 to 300 feet. Three of them were killed instantly and the fourth died later in a hospital. An element of irony was added by a report that a few seconds before the accident the men had jokingly told a small boy to "get out of here as the boiler is going to explode and kill everyone within a mile of the place." The boy ran to a grisp mill on the property where his father was eating his lunch and as he entered the door the boiler exploded.

* * *

When a boiler blew up at an Arkansas mine, on November 22, 1934, two men who were in the boiler room were killed, the engine room was demolished and three automobiles parked outside were damaged. The parts of the boiler were scattered about the vicinity. About 50 men had been standing near the boiler a few minutes previously, warming themselves before going into the mine.

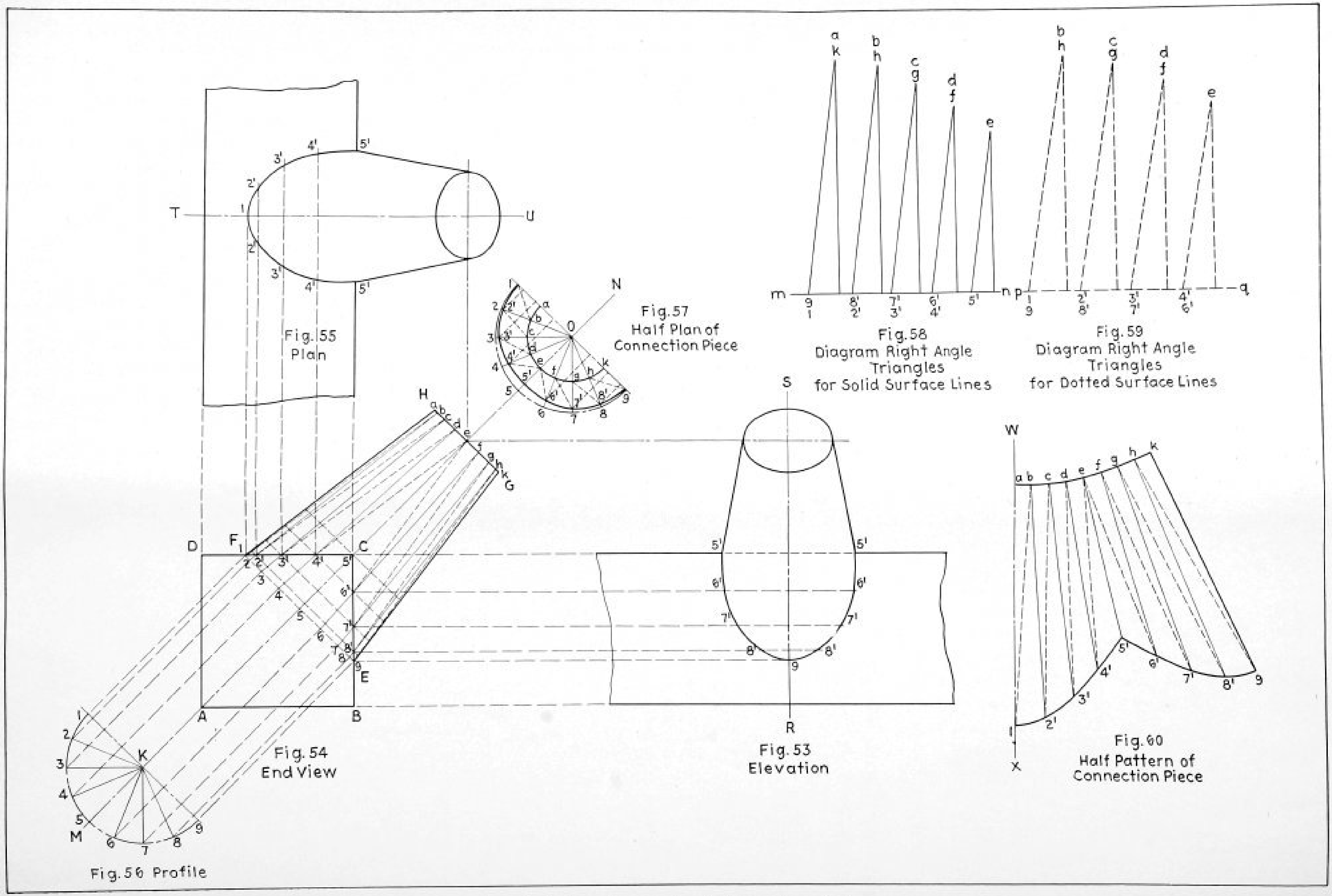
* * *

A laborer was fatally injured at an oil well near Hutchinson, Kansas, on December 17, 1934, by the explosion of a locomotive type boiler, one unit of a battery used in oil field operations. The boiler, which was set between two others, traveled upward, coming to the ground about 150 feet from its original location. The boiler shed was demolished, parts of it falling on the man who was injured.

* * *

The explosion on November 16, 1934, of a track locomotive boiler belonging to a West Virginia coal mining company injured the engineer and fireman and wrecked the locomotive. The initial failure occurred in the crown sheet while the engine was engaged in shifting cars below the coal tipple. The force of the explosion was enough to lift the locomotive off the track and throw it on the embankment. The engineer was able to crawl from the wrecked cab after the accident while the fireman was knocked unconscious and had to be rescued by the train crew. Indications were that the crown sheet failed due to overheating caused by low water.

* Published through the courtesy of *The Locomotive* of the Hartford Steam Boiler Inspection and Insurance Company.



Layout of a tapered connection, joining a square duct

PRACTICAL PLATE DEVELOPMENT—VI

Connection Piece

By George M. Davies

The next development to be considered is that of a tapered connection, joining a square duct; the tapered connection joining the square duct on the diagonal of the square as illustrated in Fig. 54.

A-B-C-D, Fig. 54, represents the end view or section of the square duct and *E-F-H-G* the tapered connection having a diameter *G-H* at the small end and a diameter *E-F* at the large end. The diagonal of the square *A-C* bisects the diameter *E-F*.

Extend the diagonal of the square *A-C* as *M-N* and at any point *K* on *M-N* construct the half profile of the large end of the connection piece, Fig. 56, making the diameter *1-9* equal to *E-F*.

Divide the half profile into any number of equal parts, eight being taken in this case. The greater the number of equal parts taken the more accurate will be the final development. Number the points from *1* to *9* as shown. Then parallel to the center line *M-N* draw lines through the points *1* to *9*, Fig. 56, cutting the line *E-F*. Number the intersections on *E-F* from *1* to *9* as shown. Then with any point as *O*, on the line *M-N*, as a center, draw the half circle *a-k*, making the diameter *a-k* equal to *G-H*, Fig. 54.

Divide the semicircle *a-k* into the same number of equal parts as taken for the profile Fig. 56. Number these divisions from *a* to *k* as shown. Then parallel to *M-N* draw lines through the points *a* to *k* cutting the line *H-G*; number these points from *a* to *k*, as shown. Connect the points *a-1*, *b-2*, *c-3*, to *k-9* with solid lines as shown in Fig. 54. Where the line *b-2* cuts the line *D-C* locates the point *2'*; where the line *c-3* cuts the line *D-C* locates the point *3'*. In the same manner locate the points *4'* to *8'* as shown.

Connect the points *b-1*, *c-2'*, *d-3'*, *e-4'*, *e-6'*, *f-7'*, *g-8'*, *h-9*, Fig. 54, with dotted lines. Lines *a-1*, *b-2'*, *c-3'*, *d-4'*, *e-5'*, *f-6'*, *g-7'*, *h-8'*, *k-9* represent the solid surface lines and *b-1*, *c-2'*, *d-3'*, *e-4'* *e-6'*, *f-7'*, *g-8'* and *h-9* the dotted surface lines of the connection piece.

The true lengths of these surface lines are required to make a development of the pattern. To obtain the true lengths of these lines, it is necessary to construct a series of right angle triangles. To construct these triangles it is first necessary to obtain the true lengths of the altitudes and bases of them.

The bases are obtained from the half plan, Fig. 57, which is constructed as follows:

With *O*, Fig. 57, as a center and with a radius equal to *K-1*, Fig. 56, draw the semicircle *1-9*, Fig. 57, and divide it into the same number of equal parts as taken in the profile, Fig. 56. Number the divisions from *1* to *9* corresponding to points *1* to *9*, Fig. 56. Connect the points *1* to *9* with the center *O*.

Next erect perpendiculars to the line *M-N* through the points *1*, *2'*, *3'*, *4'* and *5'*, cutting the line *F-H* and to the points *5'*, *6'*, *7'* and *8'*, cutting the line *G-E*.

Then with *O* as a center and with a radius equal to the perpendicular drawn through the point *2'*, Fig. 54, (i.e., the length of the perpendicular through point *2'* measured from *M-N* to *F-H*), scribe an arc cutting the line *O-2* locating the point *2'*, Fig. 57. Continue in this manner locating the points *3'*, *4'*, *5'*, *6'*, *7'* and *8'*, Fig. 57.

Connect the points *a-1*, *b-2'*, *c-3'*, *d-4'*, *e-5'*, *f-6'*, *g-7'*, *h-8'* and *k-9* with solid lines, these lines will be the bases of the right angle triangles of the solid surface lines of the end view, Fig. 54.

Connect the points *b-1*, *c-2'*, *d-3'*, *e-4'*, *e-6'*, *f-7'*, *g-8'* and *h-9* with dotted lines. These lines will be the bases of the right angle triangles of the dotted surface lines of the end view, Fig. 54.

To construct the right angle triangles for the solid surface lines as shown in Fig. 58, draw any line *m-n* and erect a perpendicular to it. From the perpendicular step off on *m-n* the distance *a-1*, taken from Fig. 57, locating the point *1*, Fig. 58. On the perpendicular to the base line *m-n* step off a distance equal to the vertical distance from the line *H-G* to the point *1*, Fig. 54, locating the point *a*, Fig. 58. Connect *a-1*, Fig. 58, which line is the true length of the surface line *a-1*, Fig. 54.

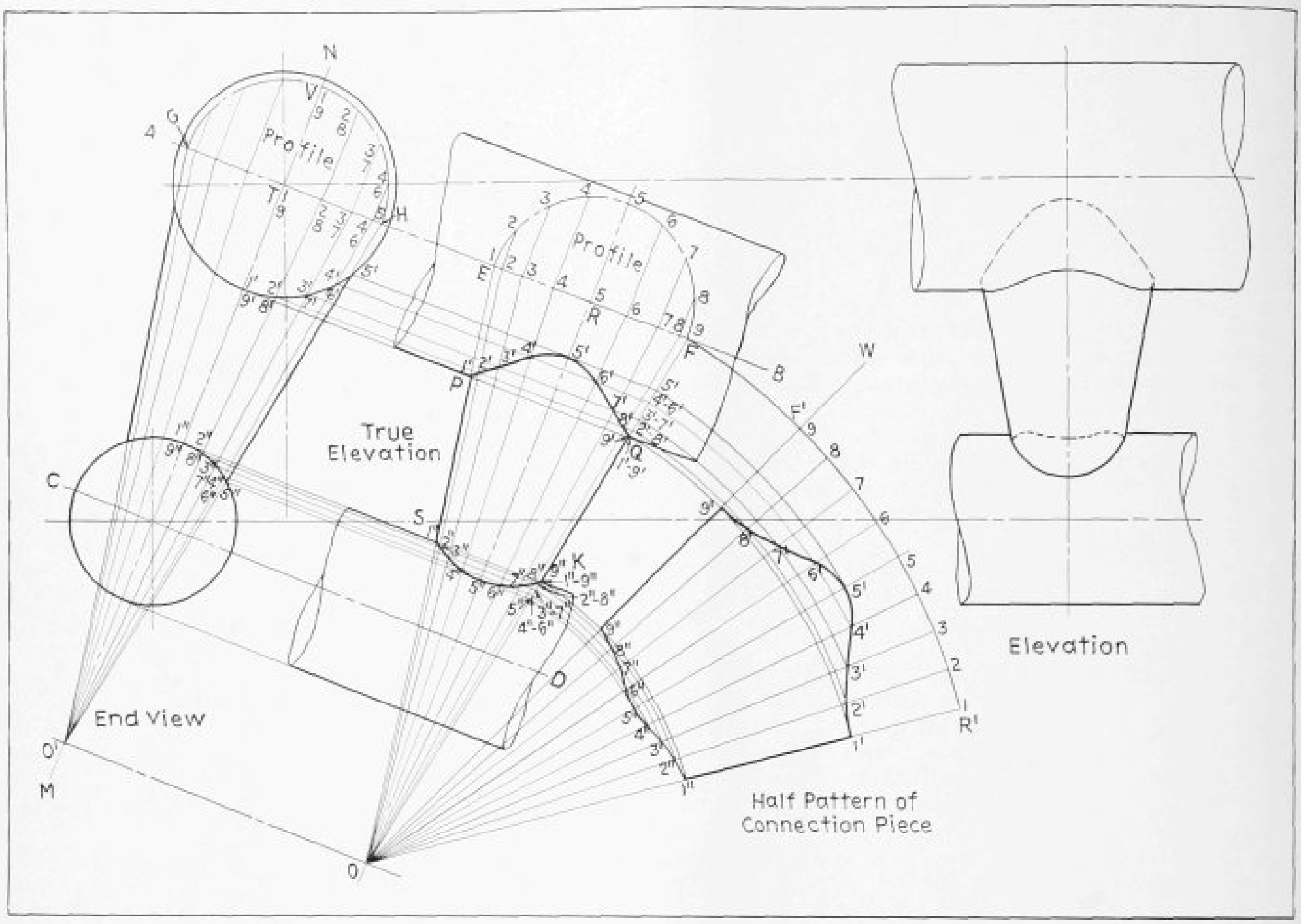
Continue in this manner, using the distances *2'-b*, *3'-c*, *4'-d*, *5'-e*, *6'-f*, *7'-g*, *8'-h* and *9-k*, Fig. 57, as the bases, and the perpendicular distances from the line *H-G* to the points *2'*, *3'*, *4'*, *5'*, *6'*, *7'*, *8'*, *9*, Fig. 54, as the altitudes, completing the series of right angle triangles for the solid lines as shown in Fig. 58.

The true lengths of the dotted surface lines are obtained in the same manner, the bases being the dotted lines in Fig. 57 and the altitudes taken from Fig. 54, constructing the right angle triangles for the dotted lines as shown in Fig. 59.

The next step is to develop the opening in the square duct, where the connection piece intersects it as shown in the elevation and plan views.

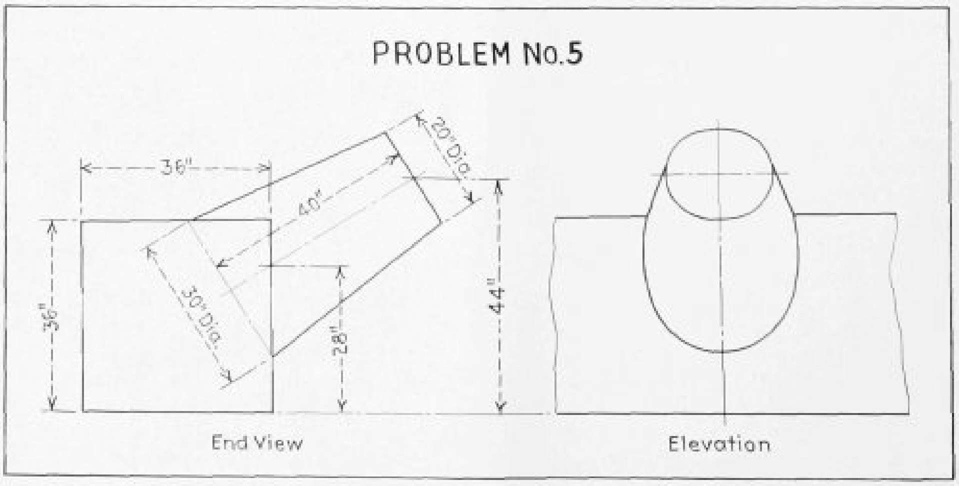
Parallel to *D-C* draw lines through the points *5'*, *6'*, *7'*, *8'* and *9*, cutting the line *R-S*, Fig. 53. On either side of the line *R-S* on the line drawn through *5'*, Fig. 54, step off a distance equal to the vertical distance from the line *1-9* to the point *5'*, Fig. 57, locating the point *5'*, Fig. 53. Then on either side of the line *R-S* on the line drawn through *6'* of Fig. 54, step off a distance equal to the vertical distance between the line *1-9* and the point *6'*, Fig. 57, locating the point *6'*, Fig. 53. Continue in this manner locating the points *7'*, *8'* and *9*, Fig. 53, completing the intersection of the connection and the duct on the side *C-B*.

Problem No. 3—Correct Layout



Solution of "Transition Piece" practice problem, which appeared on page 159 of the June issue

Problem No. 5—For Readers to Lay Out



Practice problem No. 5 demonstrates the principles applied in the article in this issue on connection pieces. The correct solution will appear in the October issue

The development of the intersection between the connection and the duct in the plan view, Fig. 55, is obtained in the same manner as shown.

Before proceeding with the development of the pattern it will be noted that the lines *T-U* in the plan and *R-S* in the elevation, divide the connection piece into two symmetrical halves and therefore a development of one-half the connection piece can be made; a duplicate of this pattern would complete the development of the connection piece.

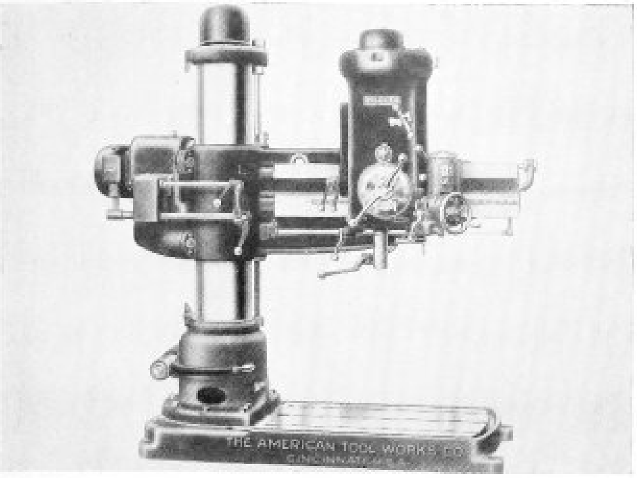
To develop the pattern, draw any line as *W-X*, Fig. 60, and step off the distance *1-a* equal to *1-a*, Fig. 58. Then with *a*, Fig. 60, as a center and with the dividers set with a radius equal to a-b, Fig. 57, as a radius scribe an arc. Then with *1* as a center and with a radius equal to *1-b*, Fig. 59, scribe an arc, cutting the arc just drawn locating the point *b*, Fig. 60. Next with *1*, Fig. 60, as a center and with a radius equal to *1-2'*, Fig. 55, as a radius scribe an arc. Then with *b*, Fig. 60, as a center and with a radius equal to *b-2'*, Fig. 58, scribe an arc intersecting the arc just drawn, locating the point *2'* Fig. 60.

Next with *b*, Fig. 60 as a center and with a radius equal to *b-c*, Fig. 57, scribe an arc. Then with *2'*, Fig. 60, as a center and with a radius equal to *2'-c*, Fig. 59, scribe an arc cutting the arc just drawn, locating the point *c*, Fig. 60.

Continue in this manner, making *c-d*, *d-e*, *e-f*, *g-h*, *h-k*, Fig. 60, equal to the same distances in Fig. 57, and the distances *2'-3'*, *3'-4' to 8'-9* equal to the same distances in Figs. 53 and 55. Also make the lengths of the solid and dotted surface lines equal to their corresponding lengths in Figs. 58 and 59, until the points *k-9* are located. Connect all the points thus obtained with a solid line completing the half pattern as shown in Fig. 60.

The outline shown in the elevation, Fig. 53, in the end view, Fig. 54, and the plan view, Fig. 55, is taken on the neutral axis of the plate. The pattern does not make any provision for welding the seams. The practice is to bevel the edges of the plates and to provide a gap between the plates after they are rolled for making the welds. Allowance should be made in the length and width of the plates, and the edges of the developed plates should be machined for the type of weld required.

(*To be continued*)



American triple-purpose radial drill

them. Through these two levers the six gear box speeds can be controlled. From the head, with a movement of the lever, the operator may clamp or unclamp and raise or lower the arm through a safety elevating mechanism. To make the swinging of the arm easy a special ball bearing is interposed between the column and sleeve at the bottom while at the top a ball bearing is interposed to take the radial thrust of the sleeve. The column binding lever extends well to the front, where it can be conveniently reached by the operator.

Typical of this line of American radials is the 5-foot radial with a column 15 inches in diameter. This machine will drill to the center of a 120-inch circle and has a maximum distance from spindle to base of 66 inches. The spindle traverse is 18 inches and the hole in the spindle will take a No. 5 Morse taper. The traverse of the drill head on the arm is 49¼ inches and of the arm on the column 33½ inches. This machine has 15 feeds having a range of 0.004 inch to 0.125 inch. The spindle speeds range from 23 to 1200 revolutions per minute. The net weight of the 5-foot machine is 13,000 pounds.

Triple Purpose Radial Drill

Among recent developments of the American Tool Works Company, Cincinnati, Ohio, of interest to railroad shop men in the line of American Triple-Purpose radial drills ranging in arm lengths from 3 feet to 12 feet. These radials are designed to handle a wide variety of operations varying from large boring and tapping to the average high-speed drilling in cast iron and steel. The quadruple geared head of this machine has four speeds which are divided into two distinct ranges; one for high-speed drilling and light tapping and the other for heavy tapping and boring. The head mechanism is fully enclosed, there being no running parts exposed. In the design of these American radials specific attention has been given to the centralizing of controls so that it is possible to operate the machine from the normal working position. The gear box speed control levers have been extended to the arm girdle, where on all smaller size machines they can be reached without moving from the operating position, while on the larger sizes rarely more than one step is ever required to reach

A New Paint Development

The protection of ferrous-metal surfaces against the destructive action of oxidation through the use of the oxide coating itself, is a new and important development in the paint field. It is extremely interesting that, instead of requiring hours of labor for its removal, the rusted surface becomes an essential part of the protective coating, forming a light-proof color body that is unusually resistant to the action of acids, alkalis and the destructive forces of nature.

The paint is doubly positive in its protective qualities since it is made on a Tornesit base, which shows approximately 99 percent proof against moisture penetration. Tornesit (or chlorinated-rubber) provides a base which forms a non-inflammable and very tough film with great adhesive powers. In fact, no other film approaches Tornesit in resistance to acids, alkalis and other corrosive and destructive elements to paints.

As has already been noted, the removal of rust is not only unnecessary but also undesirable, a fact which constitutes a great saving. Coupled with this is a rapid drying rate, ease of application and long life under adverse conditions, all making for economical protection of valuable property. Weathering improves rather than deteriorates the quality of the paint as each fresh contact with water or moisture regenerates the protective elements of the coating. This regeneration has been observed in coats three years after application. Sunlight likewise has a beneficent effect upon the painted surface.

Due to the unique qualities of this paint, it is claimed as the solution to many industrial and marine painting problems. Being equally resistant to acids and alkalis and their fumes, oils and oil fumes, and being improved by salt or fresh water, makes this paint, which utilizes the rusty surfaces heretofore removed, an object of interest wherever there are paint problems concerning the saving of ferrous-metal structures. This new paint is manufactured by The Harrington Paint Company, Inc., East Cleveland, O.

American Oil Burner Institute Created

At a two-day meeting held in Cleveland on July 9 and 10, attended by the key manufacturers in the oil burner industry and presided over by W. J. Smith, president of the American Oil Burner Association and vice-president of the Cleveland Steel Products Corporation, the creation of the Oil Burner Institute to succeed the association and the adoption of a broad-gage program was unanimously voted.

The new program contemplates a broadened membership to include all manufacturers of oil-burning appliances in the United States and the inauguration of detailed plans which will exert a stimulating influence of far-reaching benefits to oil producers and refiners as well as to the oil-burning appliance manufacturers themselves.

Present members of AOBA will automatically become members of the new Oil Burner Institute.

The following were named as the immediate objectives of the new organization:

1. Formation of a strong solidified organization to carry out the mutual objectives of all oil-burning appliance manufacturers and affiliated interests in the United States.

2. Promotion of high standards of equipment, establishment of an O. B. I. symbol of approval, and its national exploitation.

3. National vigilance to oppose passage of unfair and unreasonable laws, ordinances and regulations through co-operation with the membership in various sections of the country affected.

4. Compilation and distribution of essential trade information and data for advancement of the industry and enlightenment of the public.

5. Promotion of free exchange of information between members looking toward increased economy and profits.

6. An aggressive program for advancement, including an annual exhibit or show, to assure a growing recognition among manufacturers of progress to be made through solidarity of planned co-operation and action with each other and with each of the component elements of the allied industries and services.

President Smith announced the selection by the executive committee of G. Harvey Porter of Baltimore as managing director of the new institute. Mr. Porter has been for many years and will remain as the operating vice-president of The Industrial Corporation of Baltimore, a financing and managing organization. In addition to these duties, however, he will personally direct the work of the institute.

At the conclusion of the Cleveland meeting Mr. Smith made the following statement:

"The program we have unanimously adopted at this meeting is undoubtedly the most far-reaching step ever taken by our industry. I know that we are all solidly behind this program and in complete sympathy and accord with the objectives we have undertaken. They will be of untold benefit to us all."

New Type of Pneumatic Hose

The Mechanical Goods Division of U. S. Rubber Products, Inc., New York, has announced a new type of hose for pneumatic tool and air drill service—the U. S. Super Royal Cord, the only air hose built like a tire.

The outstanding feature of the new hose is its "tire-like" cords laid in tough rubber cushions isolated from adjacent plies to prevent rubbing or shearing. The manufacturer claims that this hose can withstand any amount of pulsation, sudden expansion under pressure and constant flexing in use.

This new hose carcass makes U. S. Super Royal Cord so tough, it is said, that it shows remarkable resistance to external blows, bruises and abrasions. This durability is due, not only to the internal structure, but to the specially compounded brown rubber cover, which will stand unusual abuse and will not peel when cut or gouged.

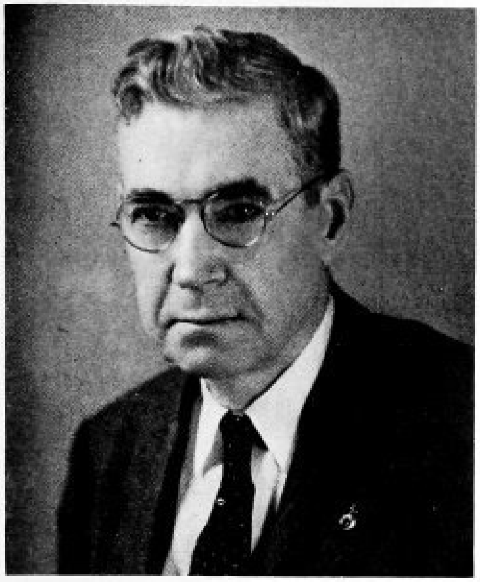
For additional protection against the destructive action of hot oil in the air line, the tube of the U. S. Super Royal Cord is made of the finest oil-resistant rubber.

Department of Commerce Reports on Industrial Machinery in Foreign Countries

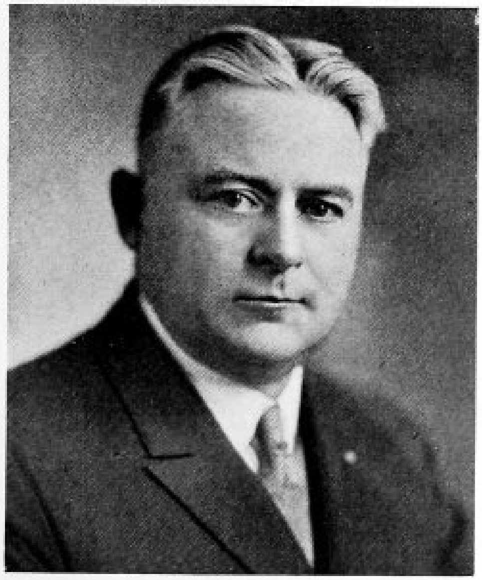
The United States Department of Commerce, Bureau of Foreign and Domestic Commerce, has issued a trade information bulletin, designated as No. 825, entitled "Industrial Machinery in Principal Foreign Countries." The introduction of this bulletin states: Industrial machinery is of prime importance in many phases of the national economy of the United States. We look to the efficiency of our tools of production for the maintenance of our standard of living. This country is the largest producer of industrial machinery.

Among our machinery manufacturers and all persons concerned with capital-goods industries there is a natural interest in what is going on in the machinery field in the foreign nations that are the principal producers of machinery. With this in mind, the Machinery Division of the Bureau of Foreign and Domestic Commerce arranged for the preparation of reports by the field officers of the Bureau in the United Kingdom, Germany, France, Italy, Sweden, Austria, and Japan, which are reproduced in this bulletin.

An endeavor has been made to indicate what kinds of equipment are included in the important types of machinery that are made in each of these countries, and the chief items that these countries find it desirable to import. In addition, data as to machinery exports are included in as much detail as was found available.



Alonzo G. Pack



John M. Hall

Locomotive Inspection Chief A. G. Pack Retires—J. M. Hall His Successor

Alonzo G. Pack, chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission, retired on July 31. John M. Hall, assistant chief inspector, was appointed by President Roosevelt to succeed Mr. Pack and J. B. Brown was promoted to assistant chief inspector. These appointments were confirmed by the Senate on August 5.

Mr. Pack entered the service of the bureau as district inspector by civil service appointment in August, 1911; in January, 1914, he was appointed by the President and confirmed by the Senate as assistant chief inspector; he was appointed by the President and confirmed by the Senate as chief inspector effective July 1, 1918. The Bureau of Locomotive Inspection under his direction has made an enviable record. The circumstances were not auspicious when he took charge as chief inspector on July 1, 1918, at a time when the condition of motive power was at a low ebb and the force of inspectors seriously depleted due to transfers to other activities. Through the exercise of judicious patience and fair but firm dealing with all concerned Mr. Pack won the confidence and co-operation of the railroad officers and employes, the results of which culminated, in 1932, in the best condition of locomotives in service and the lowest accident rate ever recorded. There has been a slight recession in the condition of locomotives in service and a small increase in the yearly number of accidents since 1932 caused by the desperate situation in which the railroads find themselves, rather than by any diminution of Mr. Pack's efforts or lack of co-operation on the part of the railroads in effectuating the purpose of the locomotive inspection law.

The original Act applied only to locomotive boilers and appurtenances; a subsequent amendment extended the scope to include the entire steam locomotive, and a later amendment included all locomotives without regard to the source of power. Because of the changes of requirements the accident statistics do not lend themselves to ready comparison over periods of years but the record of boiler explosions or crown sheet failures may be taken as indicative of the improvement in the accident situation. In the fiscal year ended June 30, 1934, as compared with the fiscal year ended June 30, 1912, the first year the boiler inspection act was operative, there was a reduction of 92.6 percent in the number of accidents, a reduction of 94.8 percent in the number of persons killed, and a reduction of 89.9 percent in the number of persons injured.

A large part of this reduction in boiler explosions was undoubtedly brought about by investigations initiated and conducted by Mr. Pack with respect to the accuracy of boiler water level indicating devices. These investigations showed that gage cocks which were entered directly into the boiler gave a much higher reading under certain conditions of operation than the actual water level in the boiler. After this was determined further experiments were made which resulted in development of a water column with gage cocks and water glass attached which overcame the difficulties incident to false indications of water level. A complete account of these experiments together with recommendations in connection with the application of water columns was published in Mr. Pack's annual report for the year ended June 30, 1920.

Mr. Pack early pointed out and continually stressed in his numerous addresses before mechanical associations and railroad clubs that a direct relation existed between the condition of locomotives, accidents, and efficiency and economy of operation.

John M. Hall, who has been appointed by President

Roosevelt and confirmed by the Senate as chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission, was born May 20, 1879, in Kent county, Md. He was educated in the public schools and took a course in general mechanical engineering with the Scranton Correspondence School. His entire railroad service was with the Pennsylvania. From 1899 to 1903 he was in the signal department as laborer, signal repairman, and inspector. From 1903 to 1904 he was employed as a brakeman. From 1904 to 1909 he was a locomotive fireman and from 1909 to 1911 a locomotive engineer. On October 9, 1911, he was appointed locomotive boiler inspector, Interstate Commerce Commission, and was assigned successively to three districts, with headquarters at Fort Worth, Tex., Philadelphia, Pa., and the Virginia-Maryland district. On July 13, 1918, he was appointed assistant chief inspector.

John Brodie Brown, who has been appointed assistant chief inspector of locomotives in the Interstate Commerce Commission's Bureau of Locomotive Inspection, was born May 25, 1881, at Montreal, Canada. After a common school education he took courses in locomotive running and mechanical engineering with the International Correspondence Schools. From October, 1900, to July, 1902, he was a fireman on the Great Northern, from July, 1902, to October, 1905, fireman on the Oregon-Washington, and from October, 1905, to January, 1912, engineer on the same road. On January 16, 1912, he was appointed district inspector of locomotive boilers of the Interstate Commerce Commission, for the district of Oregon and Washington, and he has continued in that capacity until his new appointment as assistant chief inspector.

World-Famous Steam Boiler Expert Dead

With the death at the end of July of Charles Edmund Stromeyer, M.I.C.E., M.I.M.E., there passed one of the world's greatest steam boiler experts. For over 30 years Mr. Stromeyer was chief engineer of the Manchester Steam Users' Association and his annual report was full of information of great value to boiler makers and users; it was quoted by the technical press all over the world. Mr. Stromeyer was 79 at the time of his death.

Born at Sutton, England, he served his apprenticeship in engineering works in London, studied engineering, and graduated at Aix-la-Chapelle. In his early years he worked in marine engineering works on the Tyne, and as a sea-going engineer, becoming in 1880 engineer surveyor to Lloyd's Register of Shipping. He was a past member of the Council of the National Physical Laboratory and of the Institution of Naval Architects. He was a past president of the Manchester Association of Engineers, a member of the general committee of the British Association for the Advancement of Science, and a member of the following institutions: Civil Engineers, Mechanical Engineers, Iron and Steel Institute, and Manchester Association of Engineers.

In the course of his long professional career Mr. Stromeyer had contributed a large number of papers to those institutions, and also to the Royal Society and to numerous international congresses. Apart from boilers he dealt with such subjects as the working and aging of steel, the fatigue of metals; the gaging of steam by chemical means; and a surface equivalent projection. He established a law of fatigue. The Council of the Institution of Civil Engineers awarded him the Telford Medal and two Telford Premiums. He was the author of "Marine Boiler Management and Construction," a standard work of reference.

A. L. Feild Becomes Professor of Metallurgy at Carnegie Institute

Alexander L. Feild, consulting engineer for the Rustless Iron Corporation of America and president of the Alloy Research Corporation, has been appointed professor of metallurgy at the Carnegie Institute of Technology. He will assume his new duties in September.

The new Tech professor received his training at the University of North Carolina and North Carolina State. When he takes over his duties at Tech he will be working only a stone's throw from the Bureau of Mines Building where for four years, from 1914 to 1918, he served as junior physical chemist and later as assistant metallurgist.

He left Pittsburgh in 1918 to accept an appointment as research metallurgist with the Union Carbide and Carbon Corporation, remaining with that firm until 1925 when he went to Canton, O., as research engineer for the Central Alloy Steel Company. After two years there he returned to the Union Carbide and Carbon Corporation. From 1929 until 1931 he was research engineer with the Simonds Saw and Steel Company.

Trade Publications

Simplex Jacks.—Simplex adjustable tank supporting jacks, together with drop forged and cast saddles are described in specification form in a bulletin issued by Templeton, Kenly & Company, Chicago, Ill. Tank supports of this character were originated with the return of brewing industry and have been adapted as supports for tanks in the oil, dairy, water softener, and boiler fields.

Welded Piping.—A booklet, issued by the Air Reduction Sales Company, New York, entitled "The Facts About Welded Piping for Buildings" is designed to show the advantages of the Aircowelding process. It is well illustrated, with photographs of typical installations, and so arranged as to permit the reader quickly to grasp the salient facts about this new method of welding pipe.

Sandblast Equipment.—The Pangborn Corporation, Hagerstown, Md., in a recent bulletin describes a new blast cleaning machine, adaptable to all types of work which entirely eliminates the need for compressed air as the abrasive driving agent. In the new cleaner a rapidly spinning wheel propels the abrasive by controlled centrifugal force. It is this feature that gives the new unit its name of Rotoblast.

Power Squaring Shears.—A bulletin has recently been issued by the Niagara Machine & Tool Works, Buffalo, N. Y., giving detailed descriptions of various machines and tools for sheet metal work. More than 33,000 Niagara shears have been built, their performance record extending back half a century. The present designs are both up-to-date and practical, incorporating features which have been developed during 56 years of specialized experience.

Nickel Cast Iron.—The properties of nickel alloy cast irons and their special applications in petroleum production equipment are outlined in a folder of data sheets recently issued by the International Nickel Company, Inc., New York. While the applications mentioned are specifically those of the petroleum industry, the data sheets should be of interest to readers who are anxious to obtain a knowledge of the metallurgy of cast iron without studying a very technical presentation of this subject.

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EDITORIAL STAFF: H. H. Brown, Editor. L. S. Blodgett, Managing Editor

Contents

Communication

Leading Supply Company Endorses Master Boiler Makers' Meeting

In response to a communication, notifying the boiler supply industry that the Master Boiler Makers' Association planned to hold a two-day business meeting at the Hotel Sherman, Chicago, September 18 and 19, the following letter was received by the secretary:

Mr. A. F. Stiglmeier, Secretary,
Master Boiler Makers' Association
Albany, N. Y.

Dear Mr. Stiglmeier:

"The friction of mind upon mind sharpens and brightens the intellect and makes men see with clearer vision those things that lead to advancement."

Your letter in reference to the business meeting of representatives of the Master Boiler Makers' Association to be held in Chicago, September 18 and 19, has been held on my desk to enable me to consider the matter carefully.

I agree with you in all you say in reference to the educational advantages of these meetings. There is more practical knowledge exchanged and absorbed in this manner than can ever be gained from books or printed data. The rank and file of the members are not as a rule "book worms," but are able to absorb and impart their knowledge much more effectively by personal contacts.

The fact of the matter is, the best and most progressive of our master mechanics today are men who have gained their knowledge by coming in actual contact with the work they are paid to perform. Books are well enough for suggestions and figures, but there is nothing like the actual practical work, and the experience to attain 100 percent perfection. I have seen evidence of this all my life. A remarkable example of this was the late J. J. Bernet, president, of the Chesapeake & Ohio Railroad, and the Van Sweringen Lines, whose career and achievements are known to every well informed railroad man. Those of us who knew him best knew he was no theorist.

The spoken word is the word that goes with practical men, and the word cannot be spoken unless there are meetings called, and we have some one to whom to speak, and to listen. Railroad officials, and business executives, know this better than any one else, and when they have these meetings, the progressive ones among them never miss one of them. Why then draw the line between the shop and the office?

The best of your shop men will one day be your presidents, or vice-presidents, to direct the energies of those in the ranks from which they sprang. The reasonableness of this statement is so apparent that it takes very little vision to see its philosophy.

By all means encourage your officials to permit you to attend this meeting, and you will return much better informed men by having attended. From a supply man's viewpoint, I endorse your meetings 100 percent. What would we know today about the necessity of better rivets if the boiler maker did not tell us how much pressure he was expected to get from the boiler he was building for a very powerful locomotive? This also holds true with any number of specialties required for a locomotive.

There is now another field of construction, namely, welding, which is of vital interest to the railroad shop man. Due to the restrictions of the Interstate Commerce Commission, and other governing bureaus, welding has not progressed with the railroads as rapidly as it has in other lines of industry. Possibly, this may be traced to the seniority method of dividing responsibility. There are in every railroad shop, younger men who know and endorse welding, but because they lack seniority their voices are not heard by those in authority. A meeting like that to which you refer will bring such men together, thereby enabling them to exchange ideas with other men like themselves in other shops, which in the end will result in the railroads being the leaders in the use of this proven method of fabrication.

Wishing you success, and with kindest regards to you,

I remain,

Very truly yours,

DAVID J. CHAMPION,

President of the Champion Rivet Company, Cleveland.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on practical boiler shop problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given special permission to do so.

By George M. Davies

Staybolt Problem

Q.—How many and what size staybolts would be required adequately to support 300 square inches in the furnace of a locomotive boiler if they were spaced 5 inches by 5 inches and the desired working pressure was 200 pounds?—F. E. B.

A.—The staybolts being spaced 5 inches by 5 inches, each staybolt would support 25 square inches. To support 300 square inches would require 300/25 or 12 staybolts as illustrated in Fig. 1.

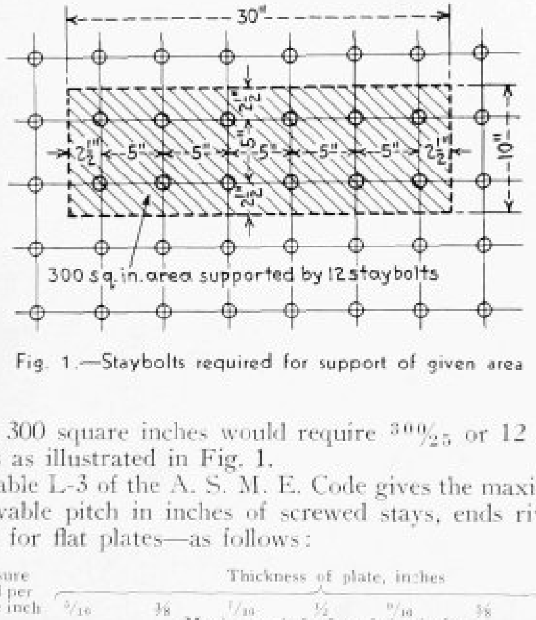

Fig. 1.—Staybolts required for support of given area

Table L-3 of the A. S. M. E. Code gives the maximum allowable pitch in inches of screwed stays, ends riveted over for flat plates—as follows:

Pressure pound per square inch	Thickness of plate, inches						
	5/16	3/8	7/16	1/2	9/16	5/8	11/16
	Maximum pitch of staybolts, inches						
100	5.590	6.708	7.826	....	....	....	....
110	5.331	6.396	7.462	....	....	....	....
120	5.103	6.124	7.144	....	....	....	....
125	5.000	6.000	7.000	....	....	....	....
130	4.903	5.883	6.864	....	....	....	....
140	4.725	5.670	6.614	7.586	....	....	....
150	4.564	5.477	6.390	7.590	....	....	....
160	4.419	5.303	6.187	7.349	....	....	....
170	4.287	5.145	6.003	7.129	....	....	....
180	4.167	5.000	5.833	6.928	7.794	....	....
190	4.056	4.867	5.678	6.743	7.587	....	....
200	3.953	4.743	5.534	6.573	7.394	....	....
225	3.727	4.472	5.218	6.197	6.971	7.746	....
250	3.536	4.243	4.950	5.879	6.614	7.349	....
300	3.227	3.873	4.519	5.367	6.037	6.708	7.372

It will be noted from this table that the firebox sheet will have to be 7/16 inch thick, in order to space the staybolts 5 inch pitch for 200 pounds boiler pressure.

In calculating stress on staybolts use supported area of stay at root of thread multiplied by the maximum pressure for which the boiler is designed divided by the net area of the stay.

Net area of stay means least cross-sectional area at any part usually at root of thread less tell-tale hole, but may be at center of staybolt in case it is reduced below bottom of thread.

The following table gives the cross-sectional area of rigid water space stays together with limiting loads.

IRON WATER SPACE STAYS—WHITWORTH THREADS—12 PER INCH

Diameter		Area, square inches		Maximum load at 7500 pounds per square inch
Outside, inches	At root, inches	At root	Net cross-sectional	
3/4	0.6434	0.3251	0.2799	2099
13/16	0.7059	0.3914	0.3462	2595
7/8	0.7684	0.4637	0.4185	3139
15/16	0.8309	0.5423	0.4971	3728
1	0.8934	0.6269	0.5871	4363
1 1/16	0.9559	0.7177	0.6725	5044
1 1/8	1.0184	0.8146	0.7694	5770

From the conditions given in the problem the area supported by each staybolt would be 25 square inches.

$25 \times 200 = 5000$ pounds load on one staybolt.

From the above table the size of the staybolt required would be $1\frac{1}{16}$ inch diameter and the actual stress on each staybolt would be

$$\text{Stress} = \frac{\text{Area supported by one staybolt} \times \text{boiler pressure}}{\text{Net cross-sectional area of one staybolt}}$$

Substituting, we have

$$\frac{(5 \times 5) - 0.7177 \times 200}{0.6725} = 7221 \text{ pounds}$$

The recommended practice for locomotive boilers for 200 pounds pressure is 3/8-inch thick firebox sheets with 1 inch diameter staybolts spaced $4\frac{1}{4}$ inches apart.

Overheating of Superheater Tubes

Q.—What are the conditions which may cause overheating of superheater tubes and how may this be avoided?—K. C. B.

A.—Overheating of superheating surfaces will be caused, if for any reason there is a condition which prevents the heat produced by the furnace gases from being conducted away fast enough to avoid overheating. If the superheating surface is located in the boiler at a point where the furnace gases are not over 1000 degrees F., there is hardly any danger of the tubes becoming overheated. Many superheaters are, however, placed in hotter positions and the prime need is to have sufficient steam circulation so that the heat may be taken up. If the superheater arrangement is such that circulation is not uniform through all the elements, some of these may be partially by-passed to such an extent as to cause overheating. It is therefore important that a definite circulation through all of the superheater tubes is secured.

When the superheating surfaces are installed so that the surface is radiant to the furnace fire, special precautions are often taken by encasing the tubes in armored blocks or behind refractory so as to reduce the intensity of the heat and secure a more uniform absorption.

In marine boilers the greatest danger of overheating superheaters comes in starting up and when steam flow is suddenly stopped, as when maneuvering. At such times the ordinary passage of the steam through the tubes is arrested and the heat is not taken away. Hence, to overcome this danger, various arrangements are provided for securing some steam flow at these times.

One method is to take the steam for auxiliaries from the superheater and then through a de-superheater in the boiler drum. This provides for a certain amount of flow at such times as the main steam flow is stopped.

In starting up a boiler the superheater can be filled with auxiliary steam by means of a suitable connection and a flow provided through the de-superheater until steam is formed in the boiler, then the connection from the auxiliary steam can be shut off. When the boiler is taken off, the superheater drain can be opened until the furnace refractory has cooled.

Another method employed is to flood the superheater with water from the steam drain of the boiler when the boiler is lighted. After pressure is raised, the water is drained back to the boiler drum and then the drain valve closed and the boiler is ready to be placed on the line.

Another practice is to open the superheater drains until some steam pressure is raised and then to close them. This drives out the air and fills the superheater with steam as soon as it is formed in the boiler. In this case care must be taken not to fire up too rapidly so as to avoid having the superheater subjected to high gas temperature.

Replacement of Defective Tube in A-Type Boiler

Q.—What is the procedure to follow for replacing a single defective tube located approximately in the center of the tube bank of express or *A*-type boilers such as Yarrow or White-Forster? A. M.

A.—If there is only one defective tube, the most logical procedure would be to fit plugs in each end of the tube and allow it to burn out. One tube more or less will not make much difference and the work entailed in removing a tube from the center of the bank is considerable.

If the tube is to be removed and replaced, it may be cut out from the steam and water drums by using a ripping chisel and knocking in the ends, when it may possibly be pulled through the tube sheet either whole or in pieces. The new tube in some designs of White-Forster boilers may then be inserted through the tube hole in the steam drum and expanded. There is sometimes an allowance made in the size of the hole in the steam drum to allow this to be done. As a practical proposition, however, it may not be possible to insert the new tube from the steam drum. In the case of Yarrow boilers it could be done only by bending the tube considerably and then trying to straighten it as it is inserted through the hole in the tube sheet. This has been done in some cases.

However, where the tubes are bent to any considerable extent, they cannot be inserted in this manner. Therefore it will be necessary to cut out a lane of tubes from one side or the other till the defective tube is accessible. It can then be cut out and new tubes inserted from outside of the drums and expanded in the usual manner.

A burst boiler tube is usually so deformed that it cannot be pulled through the tube hole into the steam drum, but a corroded tube or one with pin holes that is not deformed can sometimes be removed in this way. Tube pullers can be made by which a rod or wire is attached to a plug in the lower end and this is pulled by some device such as a screw turnbuckle or jack in the upper drum. Pouring ice water into the tube under certain conditions may loosen it somewhat by causing it to contract, and lubricating the tube hole will facilitate the pulling operation.

Strength of Welded Joint

Q.—Can a weld be made that is stronger than the plate to be welded?

A.—Yes, a weld materially stronger than the plate can be made. This may be done by means of a reinforced weld; that is, making the weld somewhat thicker than the plate or by using a welding rod that will deposit metal having greater strength than the plate. This also is possible by proper selection of material and special care in making the weld. In ordinary welding the weld, unless reinforced, is somewhat weaker than the plate. However, this decrease of strength is usually only a small amount and a well made weld in practically all cases is stronger than a riveted joint would be.

The weld also is stiffer than the material welded so that a weld can be used to give a stiffening or reinforcing rib or ring to the structure to secure additional stiffness when desired. This is made use of both in pipe welds and in building up structures.

Calking of Boilers

Q.—Please explain the reasons for inside and outside calking and when each is used on marine boilers. D. E. C.

A.—When calking is done from the inside the interior of the riveted joint and parts subjected to greatest stress are protected from the leakage of the water. In other words the joints are kept dry. This avoids corrosion in the joints as well as the possibility of concentration of scale or caustic. By protecting the joints in this manner certain possibilities of corrosion, corrosion fatigue and caustic embrittlement are avoided. The requirement of inside calking also has a tendency to produce better workmanship so that the need for heavy calking is reduced. Inside calking in certain places, especially in small drums, is somewhat more difficult and expensive because the joints are not as easily accessible. Occasionally in some places the joints cannot be made tight by inside calking. Then those places have to be calked on the outside.

The Navy has required inside calking on boilers for about twenty years. For low-pressure boilers using thin plates outside calking is often used because it is less expensive and very heavy calking is not required. With inside calking also there is a tendency for the internal pressure to keep the calking edge tight and there is less bending action on the calking edge. The best practice is to secure properly set up joints that are tight without calking and then to have light inside calking. Outside calking to be resorted to only where calking from the inside fails to secure tightness.

New Welding School in Hoboken

A new school for welding operators has been opened in Hoboken, N. J., under the supervision of William Bozman, eastern service manager for the Harnischfeger Corporation, Milwaukee. Although this new school offers a complete course in all types of ferrous and nonferrous welding, it is also maintained as a clinic where P. & H.-Hansen operators may bring any specific problems without charge for instruction.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—John M. Hall, Washington, D. C.

Assistant Chief Inspector—John B. Brown, Washington, D. C.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Director—Joseph B. Weaver, Washington, D. C.

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Boiler Code Committee of the American Society of Mechanical Engineers

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Assistant International President—J. N. Davis, Suite 522, Brotherhood Block, Kansas City, Kansas.

International Secretary-Treasurer — Chas. F. Scott, Suite 506, Brotherhood Block, Kansas City, Kansas.

Editor-Manager of Journal — John J. Barry, Suite 524, Brotherhood Block, Kansas City, Kansas.

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Office of Industrial Recovery Committee, 15 Park Row, New York

Manager—James D. Andrew.

Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President—Murrel J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

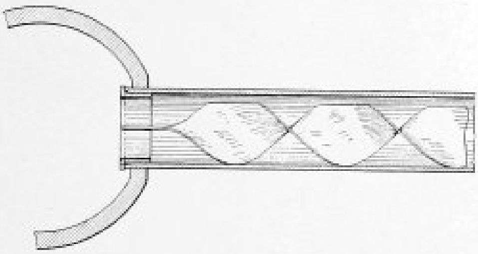
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent Attorney, 1372-1376 National Press Building, Washington, D. C. Readers wishing copies of patents or any further information regarding any patent described, should correspond directly with Mr. Galt.

1,887,130. TUBE FOR FURNACES. JAMES C. HOBBS, OF PAINESVILLE, OHIO.

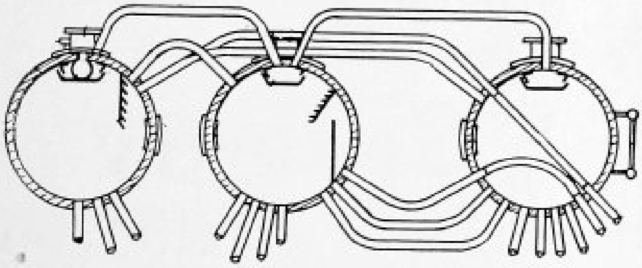
Claim.—In a steam and water circulating system, a horizontally arranged tube having its upper portion exposed to a source of heat, and



deflecting vanes in the tube constructed to cause the water in the tube to rotate, said vanes being spaced from the wall of the tube at said upper portion. Three claims.

1,887,182. MULTIPLE STEAM DRUM BOILER. JAY GOULD COUTANT, OF NEW YORK, N. Y.

Claim.—A steam boiler of the class having a system of water tubes exposed to furnace heat and a plurality of elevated steam-and-water drums all delivering to a common final outlet and each receiving steam and



water from and supplying water to the tube system and each such drum having both its inlet and its outlet connections distributed along its length whereby to secure transverse flow and substantially to avoid longitudinal flow within the drum so to minimize the steam velocity within each drum; and said boiler characterized by the particular combination of said steam-and-water drums and said water tube system wherein the steam connections extending from the tube system to the respective drums are arranged or apportioned to distribute to the respective drums the steam generated in the tube system at rates by weight approximately proportional to the volumes of the steam spaces of the respective drums and the steam outlets from the respective drums are adapted to deliver steam therefrom at rates also approximately proportional to the respective steam spaces whereby there will be maintained within all of said drums transverse flow of steam from inlets to outlets at approximately equal and therefore uniformly minimum velocities. Five claims.

Have You Changed Your Address?

Notice of change of address of subscribers should reach the office of *Boiler Maker and Plate Fabricator*, 30 Church St., New York, ten days in advance to insure delivery of the following issue to new address. Also mention your former address.

Boiler Maker and Plate Fabricator

A Beloved Friend Passes

David J. Champion, president of the Champion Rivet Company and dean of the entire boiler making industry, died at his home in Cleveland on September 10. While a member of the supply fraternity, his influence and helpfulness extended into every branch of this industry, which he had served so well throughout his life. Loved and respected by all who knew him, "Uncle Dave" will be greatly missed wherever boiler makers meet. Word of his passing came while this issue was going to press. A memorial to him will appear in the October issue.

Future Value of the Master Boiler Makers' Association

About to convene the 1935 business meeting at the Hotel Sherman, Chicago, the Master Boiler Makers' Association has announced a program of subjects pertaining to locomotive boiler practice to be covered, which, without doubt, will more than justify the confidence of railway mechanical officials in authorizing their boiler supervisors to be in attendance.

The sincere and untiring efforts of the secretary of the association, supported by the officers, are now coming to fruition in what, it is hoped, will be the beginning of a new era of usefulness to the railroads of the country in the career of this outstanding organization of railway artisans. The program which appears in this issue speaks for itself. In the time available for the preparation of committee reports, a broad cross-section of the practical locomotive, boiler and tender maintenance problems confronting the railroads has been considered. The discussion of these subjects and many more to be presented during the two-day meeting should develop a wealth of information from the wide experience of the membership that will prove of inestimable aid to the mechanical department.

It is this function of the Master Boiler Makers' Association which is most worthy of consideration by the Association of American Railroads or by any other organization concerned with railroad operation. Because of its contribution for thirty years to the solution of boiler problems, the Master Boiler Makers' Association is now obtaining the wholehearted support and approval of superintendents of motive power from all over this country and Canada.

Of the entire mechanical staff, the inspectors and supervisors in the boiler department are the first to become aware of the existence of defects in the boiler of a locomotive. The weaknesses which develop may be minor in extent or may involve the safety of the entire unit. No boiler defect, however, can be minimized. It must be corrected. The correction may involve anything from a new tube to a new firebox. It may develop along lines well understood from the experience of the boiler staff or, as sometimes happens, a new and unfamiliar weakness constituting a major problem and a potentially costly one may occur.

In any event, the investigation into its character and suggestions for the solution must inevitably come from the boiler shop staff, working in close co-operation with members of the mechanical department. The theoretical phases are settled by the engineers, but the actual work is executed by the boiler shop staff. It is extremely doubtful if, within the experience of any superintendent of motive power responsible for the condition of locomotives, the boiler supervisors were not called upon for their practical help in the solution of boiler repair and maintenance matters.

Further, it is extremely questionable if any matters pertaining to boiler materials, tools, equipment or shop practice were ever settled without the opinions and judgment of the boiler foremen being consulted.

This all leads to a consideration of what the future holds for master boiler makers collectively in their organization which has struggled with such difficulty to hold a meeting this year, not for its own aggrandizement but for the helpful work it might perform.

If, individually, mechanical officers and superintendents of motive power consider the advice and assistance of their boiler supervisors to be helpful, collectively in the Mechanical Division of the Association of American Railroads, they should recognize the contributions to locomotive boiler practice which these men, working together can make.

Unquestionably the Master Boiler Makers' Association has a place in the future scheme of railroad activities. Certainly it should be officially recognized by the Association of American Railroads even though it may not be directly affiliated as a minor branch of the Mechanical Division.

The importance of the present business meeting may best be demonstrated by the value placed upon the work of the Association by the newly appointed Chief Inspector, John M. Hall of the Bureau of Locomotive Inspection, Interstate Commerce Commission, who will address the membership at the opening session on September 18. A large group of the Bureau's staff will also be in attendance.

The economic value and the safety of motive power today, as always, depends upon the integrity of the work performed by the boiler department. Those responsible for the functioning of this department—the master boiler makers of the country—deserve every consideration from their superiors.

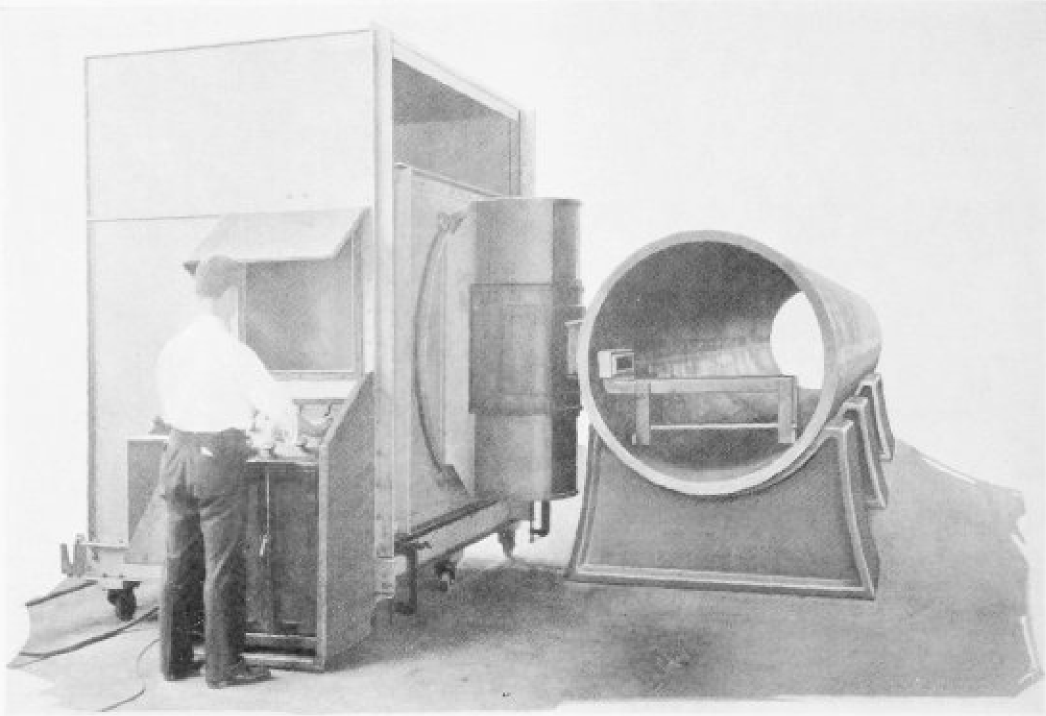


Fig. 1.—One of the first X-ray machines for examining welded joints

Developments in the X-ray method of

EXAMINING WELDED JOINTS*

By Dr. J. C. Hodge†

Non-destructive testing of welded joints in the form of X-ray examination has now been one of the requirements of most specifications and codes governing the construction of welded pressure vessels for a period of approximately three and one-half years. The subject has therefore been thoroughly discussed at many a technical meeting. No apology, however, need be made for the reintroduction of its discussion, since there are several excellent reasons for continued interest in the subject. First, it is appropriate at this time to recount the experience gained in the production X-ray testing of welded joints under the requirements of the various codes and specifications. Second, there have been improvements in X-ray apparatus and X-ray technique. Third, objections are still raised in some quarters as to the necessity for X-ray examination of welded joints, these objections being supported by recitation of the failure of the X-ray method to detect certain types of defects, and it is therefore timely to discuss the limitations of the X-ray method. Before proceeding, however, with a discussion of these main topics it is advisable to describe the development of the various non-destructive testing methods, very briefly.

The period between 1925 and 1930 witnessed major improvements in the welding art, culminating in the production of weld metal having physical properties equal to those of the parent metal. Even with the improved welding technique, however, it was necessary to develop an efficient and accurate method of non-destructively testing welded joints before welds would be generally accepted for the main joints in pressure vessels.

A number of methods of non-destructively determining the soundness of welded joints were developed.

1. The sonic method by use of the stethoscope.
2. Several methods dependent upon the disturbance of the magnetic or electrical field in a magnetic material such as iron or steel by the presence of a discontinuity in the material such as a defect in a welded joint.

A large personal element enters into a decision as to whether a weld is sound or whether it contains defects, or what type of defect by a method of this kind.

While the magnetic methods of testing welded joints have a definite field of application and are being successfully used in industry in such field, the methods were not all that could be desired for the production testing of welded joints of pressure vessels. At the time of the development of non-destructive testing of welded joints, pioneer work was fortunately being done in the examination of important castings by the radiation methods utilizing the penetrating power through opaque materials of X-rays. This method was considered the most satisfactory for the inspection of welded joints of pressure vessels since it is sensitive to small defects in the weld regardless of whether the defect is a surface or internal

* Abstract of paper presented at the tenth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors.

† Chief metallurgist, Babcock & Wilcox Company, Barberton, O.

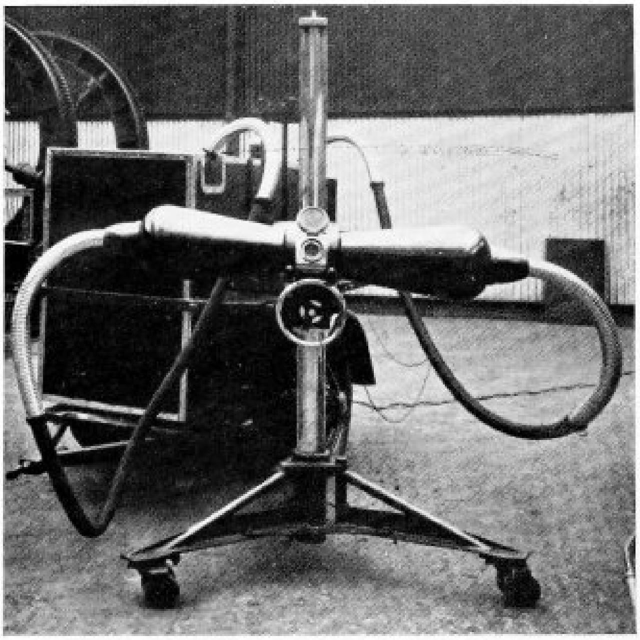
one. Its results are easily interpreted and are in a form which can be preserved for permanent record.

X-rays are produced in the sudden stoppage of fast moving electrons by matter. The high vacuum X-ray tube of the usual type accomplishes this by producing an electron emission with a heated filament and impinging the electrons on a metal target. The speed with which the electrons bombard the target is dependent on the voltage difference between filament and target, the greater the voltage the greater the electron speed and the shorter the wave lengths of the resultant X-rays. Since the penetrating power of the X-rays increase as the wave length of the waves decrease, the penetrating power of the rays may be controlled by regulating the voltage of tube operation.

The application of the X-ray method of inspection to welded joints was postponed by the inability of the X-ray tube manufacturers to produce a tube which would for production work withstand a sufficiently high voltage to permit penetration of steel of appreciable thickness. In 1929, however, sturdily built X-ray tubes of 200,000 kilovolts capacity became available which permitted inspection of welded joints in steel structures up to 3 inches thick. The method was rapidly applied to the inspection of welded joints in pressure vessels, and in the early part of 1930 an X-ray apparatus was installed in the boiler shop of one of the boiler manufacturers. In the fall of 1930 welded construction for boiler drums was permitted by the Bureau of Engineering of the United States Navy, the specifications covering such welded drums also demanding the X-ray non-destructive method. The radiographic method was also required in the Rules for the Fusion Process of Welding as formally adopted in June, 1931, by the Boiler Code Committee of the American Society of Mechanical Engineers, covering the construction of both power boiler drums and Class One unfired pressure vessels. X-ray requirements have also been written into the specifications of the Joint API-ASME Code, covering the construction of unfired pressure vessels for petroleum liquids and gases, and into the rules of the Bureau of Navigation and Steamboat Inspection for marine boiler drums and pressure vessels. X-ray requirements have also been adopted by foreign engineering survey groups, notably Lloyd's Register of Shipping.

Since the adoption of these specifications, a large number of welded boiler drums and pressure vessels for various purposes have been fabricated and installed in service, the main joints of which have been subjected to X-ray examination. Extensive experience has therefore been obtained in this method of testing welded joints. Data presented to the speaker by six of the major companies engaged in the manufacture of pressure vessels show that a total of over 3000 welded pressure vessels, representing approximately 400,000 linear feet of welded joints of thicknesses from ¼ inch to 4⅞ inches, have been examined by the X-ray method.

Approximately sixteen manufacturers of welded pressure vessels have facilities for X-ray inspection and at least one of the major users of welded pressure vessels has recently installed equipment for the inspection of welded joints in the field, these welded joints having been



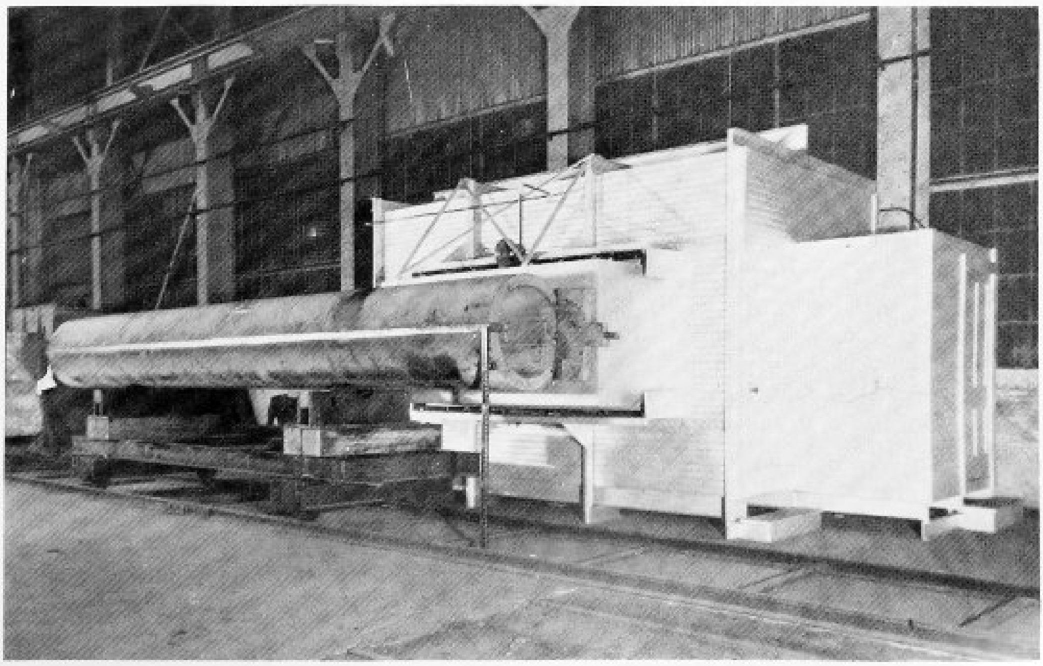


Fig. 2.—Second X-ray installation in Babcock & Wilcox plant, designed for greater penetration. Fig. 3.—(Above) Recent, portable type of X-ray equipment

made before the advent of X-ray examination in shop fabrication of the particular vessels.

Several types of X-ray equipment are in industrial use. These equipments differ only in the capacity of their

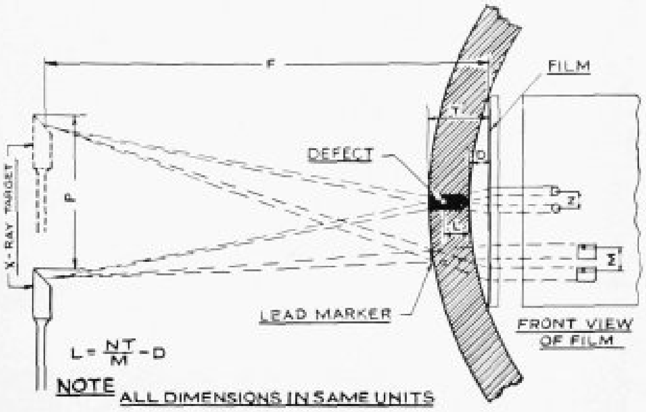


Fig. 4.—Manner in which lead marker and defect images are displace

power plants and capacity of the X-ray tubes, and in their mechanical flexibility by which the X-ray tubes may be positioned with respect to the welded joints to be X-rayed. Fundamentally they produce the same type of radiation, the standard Coolidge X-ray tube, air cooled or water cooled being employed with each equipment.

Fig. 1 shows the first X-ray equipment installed at the Barberton plant of the Babcock & Wilcox Company in the latter part of 1929. This equipment permits penetration of steel up to 3 inches in thickness, but in routine practice, however, is not generally used for plate thicknesses above 2¼ inches.

To provide for penetration through greater thicknesses a second machine was installed in 1932. This equipment has a power plant capable of developing 550,000 volts and uses a tube built for 300,000 volts and to operate continuously at 10 milliamperes. This equipment made possible the X-raying of 4½-inch thick steel plate. However, it remained even more bulky and non-portable than the original machine. A general view of the apparatus with a heavy drum 4⅛ inches thick set up for examination of the welded joint is shown in Fig. 2.

To reduce the bulkiness of the apparatus and provide flexibility and at the same time maintain the penetrating power of the 300-kilovolt tube, an apparatus was built by immersing the power plant and X-ray tube in a drum of oil. This reduced the size of the apparatus more than

Fig. 5

one-third. The case containing the oil-immersed power plant and tube is approximately 6 feet long by 4 feet by 4 feet 6 inches. This case is suspended on trunnions mounted on a movable truck, which permits a revolution of aperture of the machine through 360 degrees. The apparatus may be moved from place to place in the shop or field with comparative ease. The case containing the power plant and tube may also be raised or lowered on the lift truck. An apparatus of this type is in service at Barberton works and two such machines are in operation at Boulder Dam. A large lead-lined cone in front

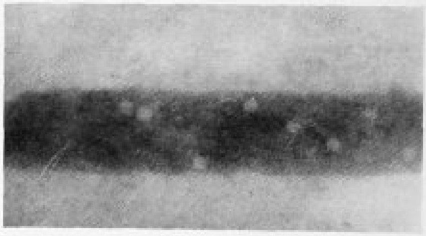


Fig. 6 (a)

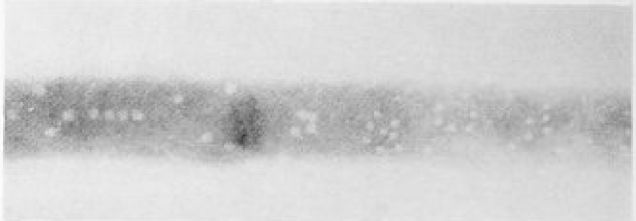


Fig. 6 (b)

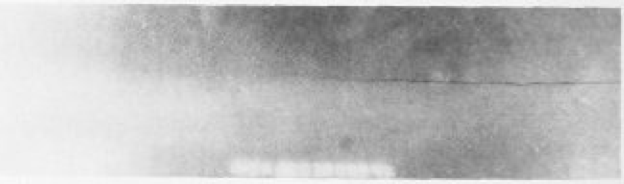


Fig. 7

Fig. 8

of the aperture of the case is mounted to minimize the amount of radiation escaping into the vicinity of the X-ray work.

To obtain flexibility of the heavy equipment previously mentioned, accessory equipment is available consisting of a shock-proof and ray-proof tube with flexible high voltage leads 75 feet long which may be attached to the power plant of the second apparatus described. Such an equipment is shown in Fig. 3. The X-ray tube is mounted in a shock-proof and ray-proof casing, which is in turn mounted on a stand. The tube casing may be rotated through 90 degrees. This support is mounted on a truck, which arrangement provides an extremely flexible apparatus. The tube is capable of withstanding a maximum imposed voltage of 200 kilovolts of continuous operation.

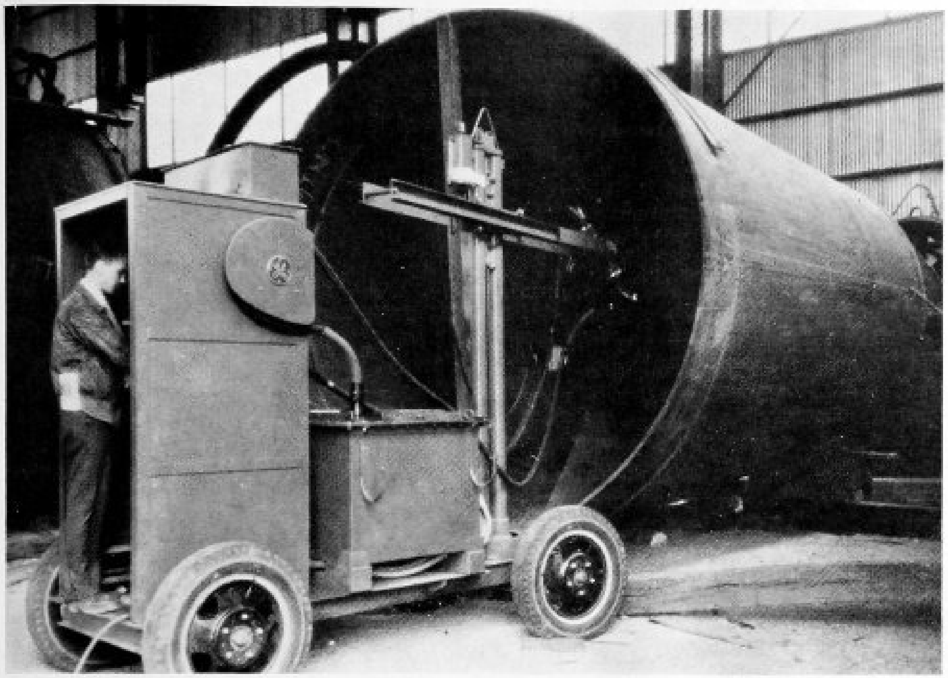


Fig. 9.—Portable X-ray equipment with truck mountings makes possible the ready examination of welded vessels in the field erecting shop

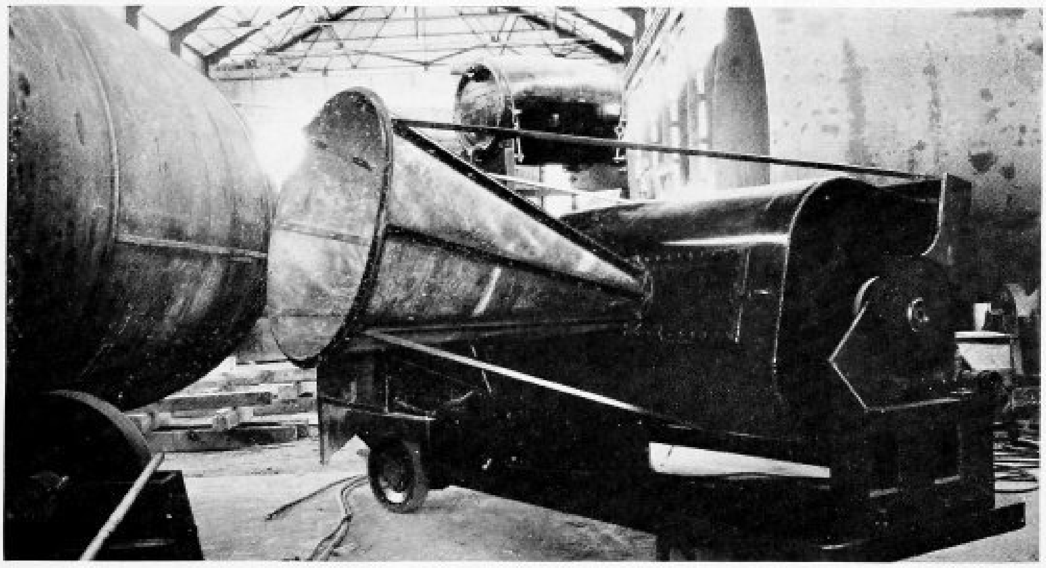


Fig. 10.—Another type of modern X-ray machine designed for field examination of welds

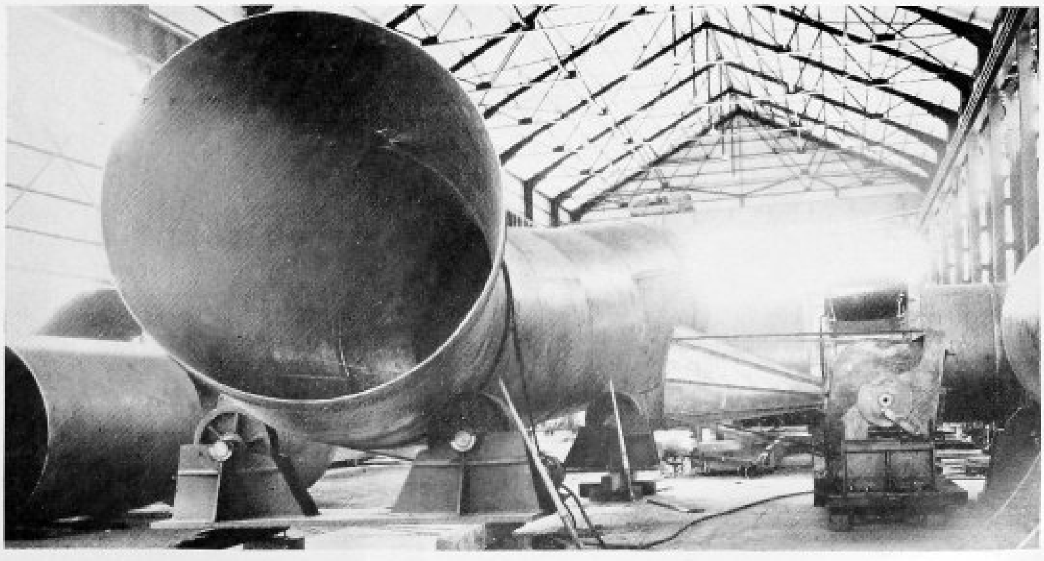


Fig. 11.—The same equipment, shown above, in use for the examination of a welded pipe section

The actual technique of making and interpreting radiographs is comparatively simple and is readily understood by anyone possessing a rudimentary knowledge of photography. In the routine inspection of welded joints, the length of weld exposed at one time will depend upon the focal distance used and the curvature of the joint. The joint is marked off in exposure lengths by prick punch marks on the outside surface and about ¼ inch from the line of fusion of the weld. Lead numbers are placed over these marks, the lead numbers corresponding to the numbers of the prick punch marks. The images of these lead numbers appear upon the film, and, since the positions of the numbers are permanently indicated by punch marks on the vessel, it is possible at any time to identify a film with its respective section of weld. Lead numbers and letters designating the drum and joint are placed on the casette holding the film. The steps involved in obtaining radiographs are as follows: (1) Layout of the weld in desired lengths and placing lead numbers as above, (2) accurately placing the weld in front of the X-ray tube, (3) placement of film on inside of vessel directly opposite X-ray tube, (4) actual exposure, (5) movement of X-ray tube or vessel to next length of weld and replacement of film. The X-ray film is placed between two calcium tungstate intensifying screens which are then placed in a casette of variable design.

The casette is essentially a light-proof case which will hold the screens and film under slight pressure. The casette containing the film and intensifying screens is placed behind the weld interval to be exposed, the X-rays coming from the target, passing through the weld and striking the casette approximately normal to the plane of the weld and to the plane of the X-ray film.

It is readily evident that since the images obtained are direct shadow projections, there will be less distortion when the film is close to the metal section and the source of radiation far away from the metal section. Since the exposure time, however, increases in proportion with the square of the distance from the source of radiation, a practical compromise must be made between sharpness of image and time of exposure. A satisfactory image is obtained when the ratio of focal distance to film distance is 7 to 1 or greater. The minimum focal distance will therefore vary with the thickness of the plate being X-rayed.

With proper technique a differential in density may be obtained on the film which will detect defects which are equal in thickness to only 2 percent, and with thin sections less than 1 inch in thickness sensitivity may be rated as 1 percent or less. For routine examination a sensitivity of 2 percent of the total thickness is considered satisfactory. This sensitivity is checked in routine examination by placing along the weld on the side towards the source of radiation steel strips known as thickness gages or penetrameters. These penetrameters are of two types, one type being used where the weld metal is chipped and ground flush with the plate material and the second type being used where the excess weld metal above the surfaces of the adjoined plates is not removed.

In the event that a defect is present in the weld and is adjudged unacceptable, this defect is removed by chipping, the cavity so formed rewelded, and the repair weld re-X-rayed. On thick welds, to minimize the amount of chipping it is advisable to make steroscopic exposures of the weld interval containing the defect to determine the location of depth of defect. The location of depth of defect is accomplished by a triangulation method. The defective section is exposed from two different angles, using the same film. Fig. 4 shows the manner in which the images of the lead marker and the defect will be displaced in such a double exposure, and gives also the method of calculation. Fig. 5 shows a punt from a double exposure X-ray film and illustrates the change in position of the defects, in this case several slag inclusions, and the image of the lead marker. This means of determining the depth of defects from the surface is accurate to within ⅛ inch, with ordinary technique.

We now come to a discussion of the various types of defects in welds and their revelation by the X-ray method. The defects which occur in welds are slag inclusions, porosity, lack of fusion of weld metal to plate, and cracks. The most common of these is entrapped slag, usually extending parallel to the wall of the joint. A very limited amount of slag as revealed by the X-ray is considered acceptable in the A. S. M. E. Code requirements. Porosity is next in order of occurrence, no difficulty being encountered in revealing varying degrees of porosity by the X-ray method. A few examples, however (see Fig. 6), will show the difficulty of defining accurately the amount of porosity which should be permissible. Various attempts have been made to define the porosity by some numerical expression, but a brief consideration of the examples shown of porous welds under the X-ray will indicate the impossibility of doing so. Attempts to produce standards by drilling holes of various sizes and with various distributions of the holes are also unsatisfactory, since it is impossible to obtain artificially the random distribution of the blowholes naturally occurring in a welded joint, and films made on such artificial standards possess a somewhat stilted appearance. The A.S.M.E. Code leaves the judgment of acceptable or unacceptable amounts of porosity to be based on comparison with standard radiographs.

It has been repeatedly stated that the X-ray method will fail to disclose zones of incomplete fusion and many cracks in welds. In the case of incomplete fusion, while it is theoretically possible to consider a mass of weld metal laid up against the walls of the joint without fusion, and with the separation between weld metal and base metal of no appreciable thickness, and hence a condition undetectable by the X-ray method, such a condition is not observable in practice, the incomplete fusion being generally accompanied by entrapped slag or by blowholes which are removed under the existing requirements.

It is possible to have extremely small zones of incomplete fusion which would be present in a welded joint and undetectable by the X-ray method. These zones would be extremely small and minor and, in my opinion, negligible as far as the inspection of X-ray joints is concerned.

In the case of cracks in welds, it is also possible to consider a crack in a weld lying in a plane parallel to the surfaces of the plate and normal to the direction of the X-ray beam, a condition undetectable by the X-ray method. To the writer's knowledge such a crack is not to be expected under the usual practice of metal arc welding, and most cracks in welds, whether they be transverse or longitudinal to the welded joint, lie in general in a plane approximately parallel to the incident X-ray beam. Under such conditions cracks are readily detectable under good X-ray technique, as shown in Figs. 7 and 8.

When X-rays strike the various particles or atoms constituting the part being radiographed, each particle sets up a secondary radiation which travels in a spherical wave from the radiating particle. This radiation, being in all directions, tends to obscure the image created by the primary rays which pass through undisturbed by the object being radiographed. This scattered radiation is constant for a given period of time of exposure, and, since the exposure time increases with the thickness, the amount of scattered radiation on the thicker plate becomes appreciable, and sufficiently intense on extremely thick plate to obscure the image or at least part of the detail of the image. The loss in detail becomes appreciable at a thickness of the order of 2½ inches, and its effect on the image of the film will be apparent on the radiographs showing 3⅞-inch thick plate. The effect of this scattering may be minimized by the use of a grid which consists of a large number of parallel strips of lead which absorb the scattered radiation, which strikes them at an angle and therefore permits only the passage of the undisturbed primary beam. A stationary grid would produce on the film an image of the grid lines, which is objectionable, and movable grids are therefore employed, which minimize the effect of scattered radiation and produce a clear image of the defects.

A movable grid for industrial purposes for the examination of welded joints has recently been perfected by the General Electric X-Ray Corporation.

The X-ray method serves as an excellent control over the experimental set-up in checking of routine welding methods.

It will be expected that in the future the X-ray method will be used more and more for the examination of welded joints and other structures in the field since the portability and flexibility of X-ray examination is increasing. An interesting example of this is shown in Fig. 10, showing a portable 300-kilovolt apparatus of the type described, working on a field job involving the examination of large diameter pipe. The focal distance of the X-ray target to the film is as high as 23 feet on this job, with 3 to 5 feet of the joint being exposed at one time.

Where welded joints are not sufficiently accessible for X-ray examination, gamma-ray inspection may be used.

The large experience gained in the X-ray examination of pressure vessel welds shows that the number of defects which are removed is relatively small. The requirements as to what is acceptable and non-acceptable under the X-ray inspection of the various specifications are extremely rigid. Under these requirements many defects are removed which would not seriously detract from the quality of the welded joints. The number of serious and dangerous defects which have been revealed by X-ray examination during production testing of the large number of welded joints referred to previously is comparatively few. These statements should not be considered as advocation of the speaker for making the X-ray requirements less rigid. Perfection can be obtained in welded joints and is being obtained under the present X-ray requirements. In review we may state that the X-ray method gives positively the nature, size and location of any defects present, enabling their removal. Routine inspection checks defects against welding technique and individual welders, hence making for more careful work, and the complete permanent film record obtained is easily and readily interpreted and gives assurance of the quality of every part of the welded joint. This statement is based on good X-ray technique and the elimination of scattered radiation for thick-walled joints.

A word should be spoken in regard to the work of the X-ray subcommittee of the Boiler Code Committee of the A. S. M. E. This committee has made recommendations, suggesting changes and improvements of the original requirements, making for better X-ray work. It is expected that such limitations as the X-ray now has will be eliminated by future development work by the various interested groups and individuals. Constant investigation and study make future progress certain.

Huge Boiler Plant Being Erected

Erection of a huge boiler, 45 feet high, at a cost of approximately $150,000, is under way in the John Morrell & Company plant at Chicago, which will utilize the most modern methods of combustion to produce an estimated 450,000,000 pounds of steam per year.

The new boiler, made necessary through increased steam consumption in the packing plant, refutes the common belief that Iowa coal cannot be pulverized and burned in suspension owing to its high ash content and tendency to fuse into clinkers.

Barney Winger, master mechanic of Morrell & Company, describes the new boiler, which will be ready for use around the first of November, as the latest development in a coal-burning, steam-generating unit.

The boiler is 21 feet wide, 22 feet deep and 45 feet high. It is a four-drum, bent-tube unit which uses the tubes to form the combustion chamber, eliminating brickwork and making possible water-cooled walls on all four sides. The boiler is heavily insulated and covered with a 3/16-inch steel jacket.

The great height is made necessary by the use of the powdered coal burned in suspension. Pulverized coal burns most efficiently, but prior to 1930 it was maintained that Iowa coal had to be burned by using a traveling stoker due to the characteristics of clinker formation.

At that time, however, Morrell's determined to test the theory, since efficient management made it necessary to use Iowa coal from the mines adjacent to the plant. It was so highly successful that the new boiler is of the same type, a suspension burner.

The new unit has a capacity of 100,000 pounds of steam per hour 24 hours a day, with a peak output of 120,000 pounds per hour. It can burn 120 tons of coal per day. It will generate at 200 pounds per square inch pressure when placed in operation, but is designed and equipped to operate at 450 pounds pressure. The excess pressure may later be used to produce electric power as a by-product.

The new boiler operates by conveying the coal direct from railroad cars to bunkers suspended from the roof. From these it is in turn fed by gravity to a pair of pulverizers driven by 120-horsepower electric motors which crush the coal into the consistency of flour.

The powdered coal then is piped into a mixing chamber where air is admitted in proper proportions before the mixture is blown into the combustion chamber to ignite in the high temperature. Fans bring in the air, mix it with the coal and a draft fan inducts it into the combustion chamber all automatically to maintain a constant relationship and provide for the highest efficiency, thus eliminating the element of human error. The fans are operated by a 150-horsepower steam turbine.

The boiler also has superheaters installed for raising the steam temperature by 100 degrees to make it more suitable for distribution through the pipes of the plant for heat, refrigeration and power.

Two means of collecting and removing the ash are required—that which drops is collected automatically by a pneumatic conveyor and carried out of the plant, to be disposed of later; the greater part of the waste, however, remains in suspension and would be carried off through the stack with the gases to settle in the neighborhood as fine dust, if a series of collectors, baffles and ducts were not provided to catch the ash as it passes from the outlet of the boiler into the stack.

The Combustion Engineering Corporation of New York built and is installing the boiler. The pulverizers are manufactured by the Riley Stoker Corporation, Worcester, Mass., and the waste traps that remove the ashes from the smoke are produced by the Pratt-Daniel Corporation of New York.

Work of the A.S.M.E. Boiler Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information on the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the council of The American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published.

Following are records of the interpretations of this committee formulated at the meeting of June 28, 1935, and approved by the council.

Case No. 791 (Reopened)

(Interpretation of Par. P-299)

Inquiry: Par. P-299 of the Code requires that valves and fittings on water lines below the water line shall be equal at least to the requirements of the American Standards for a pressure 25 percent in excess of the maximum allowable working pressure. This would apparently limit the use of the present 250-pound standard valves and fittings to 200-pound maximum allowable working pressure and also require a valve with a pressure rating of 313 pounds to be used for 250-pound maximum allowable working pressure. Since there are no tables giving flange and body thicknesses for cast-iron valves and fittings over 250-pound pressure, will it be permissible to increase the flange and body thicknesses to permit the use of cast-iron valves and fittings on water lines below the water line, up through 250-pound maximum allowable working pressure?

Reply: It is the opinion of the Committee that the present 250-pound cast-iron flange and fitting standards should not be used for the purpose described for maximum allowable working pressures exceeding 200 pounds per square inch. This also includes the valves and fittings for blow-offs.

Case No. 805

(Special Ruling)

Inquiry: Under the Unfired Pressure Vessel Code, is it permissible to use so-called slip-on welded flanges, made by fitting either a plain ring or a hubbed flange, machined on the inside to a close fit, over the end of the shell or nozzle neck and welding it thereto to form in effect a double-fillet lapwelded joint?

Reply: It is the opinion of the Committee that the types of flange described above, and shown in Fig. 30*A* and *B*, will be permissible for use on vessels constructed in accordance with Pars. U-69 and U-70, provided:

(*a*) The flange thickness *t* is at least that required for a loose-ring or loose-hubbed flange, as the case may be, of the same diameter and bolting (see Par. UA-21*a*), without considering the shell or nozzle neck to have any value as a hub;

(*b*) none of the following limits are exceeded: working pressure of 300 pounds per square inch, working temperature of 700 degrees F., required thickness of shell or nozzle neck of ⅝ inch, and ratio of inside diameter to thickness of shell or nozzle neck of 300;

(*c*) the welds attaching the flange to the shell or nozzle neck

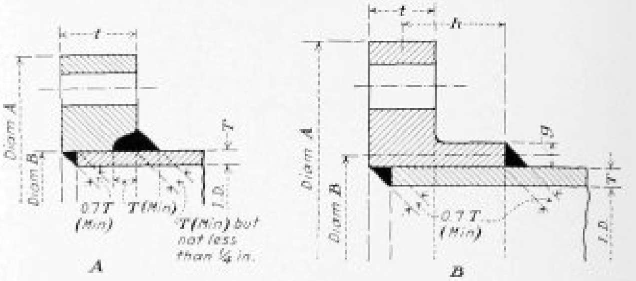


Fig. 30

have dimensions not less than those shown in Fig. 30*A* and *B*, where *T* is the actual thickness of the shell or nozzle neck; and

(*d*) the flange is slipped over the shell or nozzle neck for its full thickness minus the amount required for the weld at the flange face.

Case No. 806

(Interpretation of Pars. P-103 and U-71)

Inquiry: Pars. P-103 and U-71 of the Code do not include a specification for forgings. Will forged-steel nozzles conforming to the chemical and physical properties of Specification S-10, Class B, carbon content 0.35 percent maximum, meet the requirements of the Code?

Reply: It is the opinion of the Committee that if the material for forgings to be attached to boiler or pressure-vessel shells by fusion welding complies with Specification S-10, Class B, the intent of the Code requirements will be met.

Case No. 807

(Special Ruling)

Inquiry: At a recent meeting of A. S. T. M. Committee A-1, it was voted to approve certain modifications in Specification A 149-33T (A. S. M. E. Boiler Code Specification S-26), waiving the heat-treatment requirement and adding a lower tensile-grade material. Pending final action by A. S. T. M., will these modifications be acceptable under the Code?

Reply: Pending final action by the A. S. T. M. on proposed revisions of Specification A 149-33T, the Boiler Code Committee approves the following modifications to Specification S-26:

Par. 3*a*, *b*, and *c* may be waived.

Par. 7*a*. Introduce a Grade *A* with a tensile-strength range of 65,000/77,000 pounds per square inch. Designate 70,000/-82,000-pounds tensile range as Grade *B*. Elongation requirements for both Grades *A* and *B* $\frac{1,550,000}{TS}$ for flange quality and $\frac{1,600,000}{TS}$ for firebox quality.

Par. 7*b*. Maximum tensile strength 79,000 and 84,000 pounds per square inch for Grades *A* and *B*, respectively.

Par. 8. Minimum elongation shall be 18 and 19 percent for flange and firebox qualities, respectively.

Par. 9. Change table under Pin Diameter Specimen Thickness Ratio to read:

Grade A	*Grade B*
1½	2
2	2
2	2½

General procedure employed in

CANADIAN BOILER INSPECTION*

Province of Quebec

By N. S. Walsh†

The purpose of this paper is to describe in a general way, the main features and the application of the Law and Regulations, in the Province of Quebec, relative to boilers and pressure vessels. It was presumed appropriate to outline the extensiveness of the province in a general way, with a somewhat partial history of the recent developments leading up to the methods of application of the provincial requirements which embody boiler and pressure vessels inspection work, under present arrangements.

The Province of Quebec, in itself, extends most easterly, of the Dominion, to the Atlantic seaboard. It covers an area to the north of the provinces of Nova Scotia, New Brunswick and Prince Edward Island. It extends as far, in the North, as the Hudson Bay and James Bay; to the West, at the Ottawa River and the Province of Ontario. At its south it borders on the following states of the United States: New York, Vermont, New Hampshire and Maine.

Quebec is the most extensive province of the Dominion, having a superficial area of 703,653 square miles. It can be compared amazingly with some countries of Europe, with regards to area; for instance, it is approximately 3.5 times larger than France, Germany or Spain. As a further comparison, I might say that it is some 4 times larger than the state of Pennsylvania.

You will readily realize the magnitude of the Province of Quebec, by the figures mentioned above. I would say that the active portion could not be considered as more than half this area mentioned. At any rate, the populated area in question extends 1000 miles lengthwise, by approximately 350 miles wide.

The population is made up of approximately 60 percent French, while the remaining 40 percent are principally English-speaking. It might be interesting to note that due to this existing condition, a complication is encountered by the fact that the insurance companies must cope with a specific point of law, in that their inspectors must be conversant in the two languages, namely French and English. It also necessitates carefulness in reporting to the individual owners, or firms, in order to prevent any reproach or censure from their customers on that account.

The boiler inspection department is one of a subsidiary form, coming under the immediate direction of the Minister of Labour. It was established, in a primitive way, over 30 years ago, giving results of an equivalent character, yet, considered as satisfactory, from the point of building inspectors who were certainly favored by Providence, in those days. Incidentally, in this particular period, the majority of the inspections were most crudely dealt with; fortunately in most cases the decision of pressure was left in the hands of the insurance companies and their inspectors.

Inspection of boilers, by our department, was regarded as a necessary evil. It was actually proven by the fact that while the laws were in effect, no provision was made in the form of salary. The individual inspector had to rely entirely on his collection of fees and expenses, in order to carry on; and, it was not until 1925 that amendments to the law provided the necessary salary and expenses for the inspectors.

As time advanced and competition got to be keen, the manufacturers brought to bear a certain pressure on the government, resulting in a further revision and the final adoption of the Canadian Interprovincial Code officially, by the Legislature, as a standard of construction. Since that time, all manufacturers have submitted, for approval and registration by our department, all designs of pressure vessels proposed for operation in our province. The standard of construction, as designated by the Code, is accepted, to date, in six of the provinces of the Dominion of Canada. Incidentally, the Provinces of New Brunswick, Nova Scotia and Prince Edward Island have not, up to the present, officially adopted the code referred to; the only authority to query designs or installations, within these boundaries, is the local one of the larger cities, such as St. John, N. B., and Halifax, N. S.

The inspection of new work, which includes construction and installation, is solely in the hands of the governmental staff, whose duty it is to see that the installation is being carried out in accordance with the approved layout submitted at the headquarters of the department for registration. Following completion to the satisfaction of the authorities, a certificate of acceptance is issued and serves as a guide to any insurance company desirous of taking over this risk.

Shop inspections have been carried out, I believe, very successfully and efficiently. The majority of manufacturers of pressure vessels are within the radius of Montreal, with a resultant low cost or, in other words, a minimum of expenditure in taking care of this important branch. A mutual understanding exists between the provinces, in that pressure vessels fabricated for Ontario, or any other province in which the Canadian Interprovincial Code is officially adopted, by which the reports, as made out and supplied by the chief inspectors, are accepted.

Basing my information on the records which are now in the making, and those we have actually on file, it is apparent that fully 75 percent of the annual inspections, throughout this province, is in the hands of the insurance companies whose offices, or branch offices, are located in Montreal, and whose inspectors must be qualified in accordance with the laws and regulations of our province. The most recent change went into effect in the year 1933. This specific ruling definitely states that

* Abstract of papers presented at the tenth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors.

† Chief inspector of boilers, Department of Labour, Montreal, Que.

a copy of the reports of the insurance companies on all boilers and pressure vessels must be supplied to the department, following the annual internal inspection, as well as a copy of re-inspection reports. No special forms are asked for, or supplied by the government; the reports are accepted as made out on the forms of the individual companies by their inspectors. This, in turn, naturally avoids duplication of work by the use of any additional forms. The reports dwelt on are fully scrutinized and in the event that important recommendations are made by the inspector, we immediately intimate our cognizance of the local condition to the owners which we pursue by maintaining constant pressure through correspondence or other means of application, in order to secure the result desired, which is, of course, safety.

In the event of accidents resulting in personal injuries, whether fatal or otherwise, reports must be made out to the chief inspector of public buildings and industrial establishments on forms specially supplied for this purpose. This written notice must be forwarded to the inspector within forty-eight hours of the accident.

The information which is secured, following the investigation, is transferred to the Workmen's Compensation Board, which, alone, is responsible to decide the amount allotted in each individual case, according to the gravity of the accident; in fact, this commission is charged with the interpretation, administration and application of this law and is the only recognized authority to decide (to the exclusion of any other tribunal) what the compensation will be.

This commission is composed of three commissioners, one of whom is selected as the president. These gentlemen are assisted by a suitable staff under the charge of the following officers: Secretary, chief medical adviser, together with four technical advisers.

The investigation of the accident is carried out as shown by the following example, citing the case of boiler explosion: A representative of the boiler branch investigates the case and reports direct to the chief inspector of public buildings, who, in turn, transfers the information to the Workmen's Compensation Board, as mentioned previously.

Province of Ontario

By E. T. Urquhart*

I observe from your program that you give as the subject of this paper "Administration of the Boiler Inspection Law in the Province of Ontario, Canada." As a matter of fact the same procedure is carried out in all of the other Canadian provinces which have adopted the Interprovincial Regulations with the exception of the Maritime Provinces which have not accepted the regulations. The inspection, in the Maritime Provinces, is made after the installation of the boiler or pressure vessel by the representatives of the various insurance companies.

Previous to 1921, at which time the present Canadian Interprovincial Regulations were adopted by the Provinces of British Columbia, Alberta, Saskatchewan, Manitoba and Ontario, governing the construction and inspection of boilers and other pressure vessels, each of the provinces had regulations which varied greatly in many respects, making it necessary for the manufacturers to design boilers to suit the requirements of the boiler inspection department of the province in which the boiler was to be installed.

* Acting chief inspector, Boiler Inspection Department, Toronto, Ont.

I mention that fact because there were many difficulties in that respect at the time. It being realized by the various provinces, as well as the manufacturers, that a uniform code was most desirable, many conferences were held, resulting in the compilation and ultimate adoption of the Interprovincial Regulations.

In 1928 the said Regulations were adopted by the Province of Quebec. Although the general procedure in connection with the submission of designs for approval is identical in each of the provinces, the boiler inspection acts of the various provinces differ and certain unfired pressure vessels are exempt from inspection.

That does not apply to the Province of Ontario. There is no exemption in Ontario with the exception of one which I will read in a minute. I wish first of all, in order to avoid possible misunderstanding, to give the interpretation of a steam boiler as incorporated in the "Steam Boiler Act" of the Province of Ontario, which reads as follows:

Steam boiler shall mean and include any vessel or structure in which steam is generated for power or heating purposes, and any vessel or other appliance in which steam, gas, air or liquid is contained under pressure, and shall include all pipes, apparatus and machinery attached to, or connected with a steam boiler, but not a portable boiler rated at twenty-five horsepower or under, used exclusively for horticultural or agricultural purposes.

We may wonder why that had been incorporated in the act, and in answer to that I would say that it had been incorporated during the regime of the farmer government in the Province of Ontario a few years back and it has never been taken out of the regulations, unfortunately.

Before construction of any boiler is commenced, the manufacturer is required to submit for approval, to the boiler inspection branch, detailed drawing and specification in triplicate, together with cheque for the amount prescribed in the regulations. The drawing is checked and working pressure calculated. I may say that all calculations are placed on the back of a specification and filed with the approved drawing in the office so that it may be referred to at any time should anyone wish to operate the boiler at a higher working pressure at a later date.

If found to be in accordance with our requirements, and suitable for the pressure desired, our stamp of approval is placed thereon, having also incorporated the registration number, maximum working pressure and date. One copy of drawing and specification is returned to the manufacturer, the remaining copies being retained and filed for future reference.

Should any design be not in accordance with our requirements, the manufacturer is advised of the changes necessary, and requested to re-submit corrected copies.

The manufacturer may fabricate any number of boilers from the approved design, but shop inspection is, of course, necessary during construction.

A boiler as heretofore defined includes all unfired pressure vessels, such as digesters, steam accumulators, oil refinery equipment, refrigeration units, vulcanizers, laundry equipment, steam rolls, electric steam generators, air receivers, steam cookers or retorts, steam separators, steam purifiers, superheaters, economizers, jacketed kettles, sterilizers, converters, hydro-pneumatic and hot-water storage tanks, etc.

Registration covers a boiler of one diameter, of one material for one pressure. The length does not enter into it at all. In the case of watertube boilers, they can be built provided no change is made in the drum diameter. Drums can be made longer and the pressure may be increased as desired.

Specification forms are supplied to the manufacturers by the boiler inspection branch. Designs of all valves and other fittings, piping layout, boiler suspension arrangement and settings are also required to be submitted for approval.

For valves one registration covers one type for one pressure, and in this instance a tabulation for an unlimited number of sizes may be incorporated on the design.

It is not necessary to register separately designs of suspension and settings, but they may be accepted as details forming a part of the boiler proper, and therefore receive the same registration number as the boiler.

It is, of course, considered that that material is part and parcel of the boiler even though it does require a separate figure and calculation.

Piping designs, however, are considered independently and complete specifications are to accompany such drawings. The material, pipe sizes, type of valves and manufacturer's name, expansion joints, anchors, hangers, drains, etc., are to be clearly indicated.

We have established three series of registration numbers, one for boilers and unfired pressure vessels, one for valves and other fittings, and one for piping.

I have refrained from mentioning a fourth series of registration numbers, purposely. They refer to special rulings. We may get a special design or special construction that is not covered by our regulations which makes it necessary to issue a special ruling for that one particular type of vessel. We could not give an interprovincial regulation number because it varies from the Interprovincial Regulations Code. I hope you will never adopt a special ruling number series because we hope to do away with them eventually.

The system of design registration in Ontario has proved to be entirely satisfactory in every respect, because the manufacturers have approval of construction before any work is commenced, and the inspector making shop inspection has only to check the vessel being fabricated with the approved design. That does not necessarily mean that the inspector is not required to be thoroughly familiar with the regulations; but having a copy of the approved design in the shop at the time he is making shop inspection, makes the work very much easier for him.

I understand you are considering the advisability of establishing in the United States a central bureau where designs will require to be submitted by the manufacturers for approval, and sincerely trust you may very soon decide in favor of this action.

Steam Generator for French Locomotive

By G. P. Blackall

Something of a revolution in locomotive construction is to be introduced into a new Pacific type locomotive now under construction by the Paris, Lyons, and Mediterranean Railroad by the use, for the first time in France, of the Velox steam generator in place of the orthodox boiler. No radical change will be made in the driving mechanism, although a further interesting innovation will consist in the placing of the driver's cab in front of the locomotive.

The new steam generator is based on the principle of pressure firing, and has flue velocities which reach 650 feet per second. This is obtained by means of a gas turbine-driven blower. The gases necessary are taken from the flue, and are used to force the air into the combustion chamber at some 2 to 3 atmospheres pressure. No preheater is required, as the pressure itself heats the air. The heat transmission amounts to as much as 110,000 B.T.U's. per square foot per hour at the walls of the evaporating tubes.

The pressure under which the combustion takes place permits also a much better combustion, amounting to approximately 900,000 B.T.U's. per cubic foot per hour, so that only about one-tenth the space of the ordinary combustion chamber is necessary. Water circulation by means of a pump is employed. The governing of water level, fuel supply and combustion air is completely automatic, although it can be influenced by hand.

There is no brickwork in the firebox, all the surfaces being metallic. The small size of the elements involved in the generator permits faster acceleration and starting and stopping than with the ordinary boiler. The weight is considerably less, as is also the space required. This interesting locomotive is expected to be ready for service early in 1936.

New Ful-Vue Style Goggle

A new goggle, exactly like the well-known Ful-Vue spectacles in its appearance and in many of its design features, has just been announced by American Optical Company, Southbridge, Mass.

Chief advantages of the new goggle, as stated by the manufacturer, are its handsome appearance and its comfort, features which are expected to make it easier to

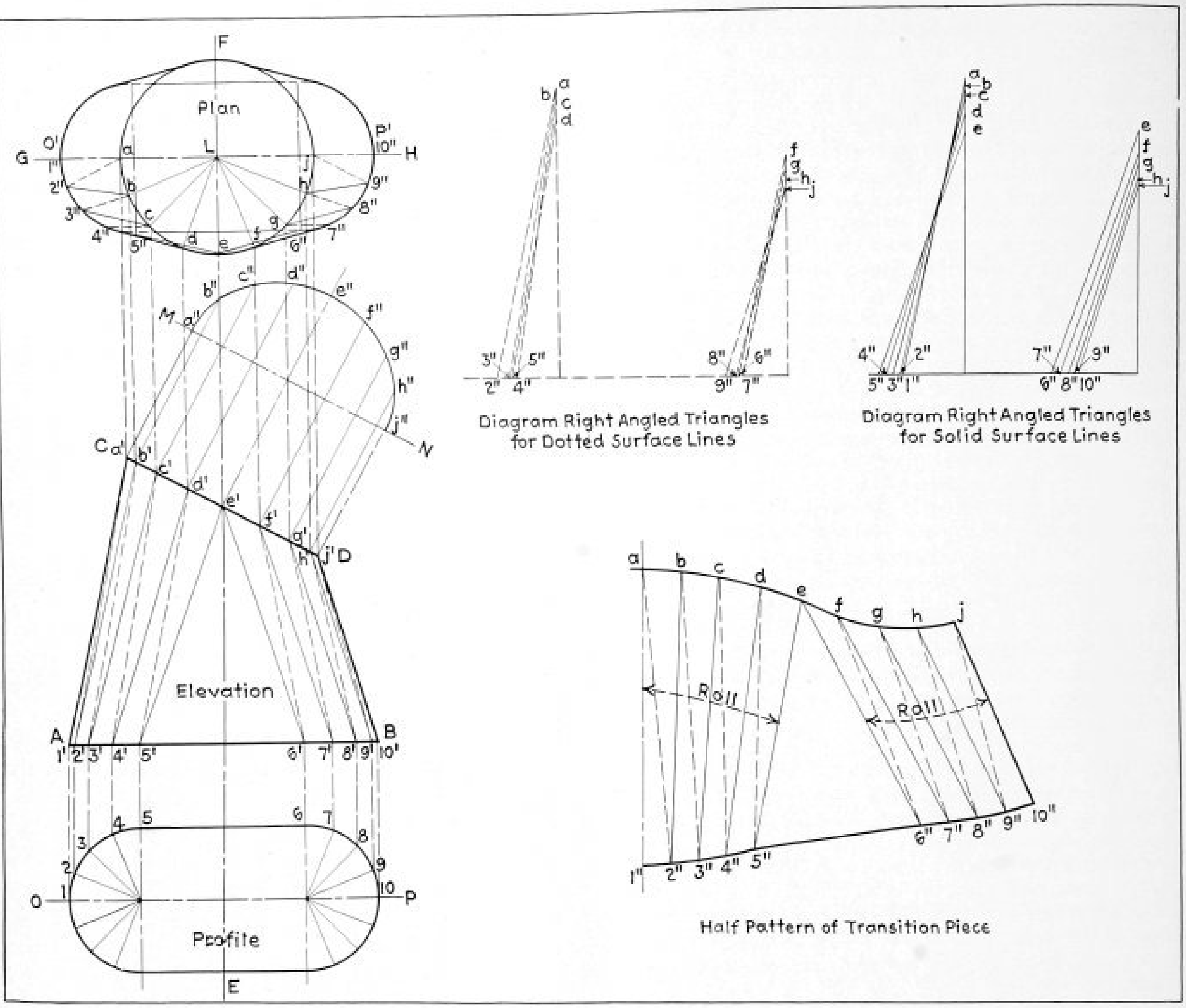
New safety goggle

enforce goggle programs. For the customary nose-piece the new goggle substitutes pearl full-rocking nose-pads which distribute the slight weight of the goggle on the sides rather than on the top of the nose. Ear-pieces are of flexible cable, completely insulated, so that no metal touches the skin at any point. As on the popular Ful-Vue spectacle frames, the ear-pieces are set high on the rims, removing every obstruction to full side vision and adding to the goggle's good-looks.

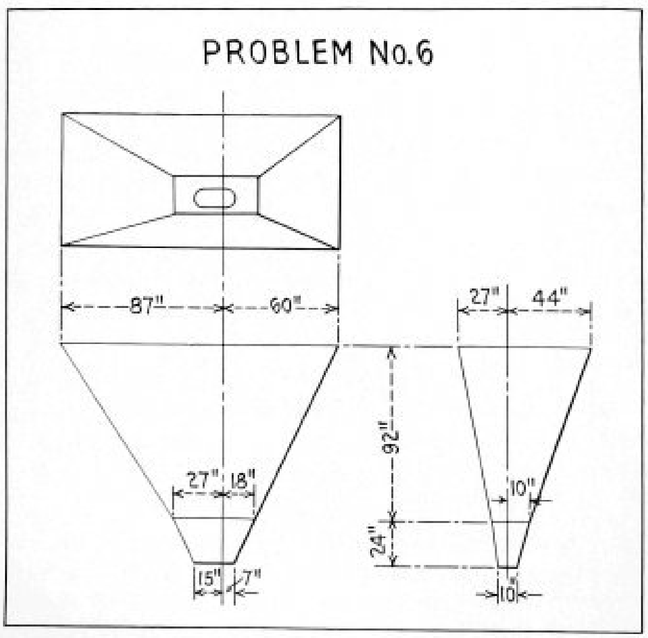
Comfortable fitting is made easy by the adjustable nose-pad supports and by the universal swivels that allow the nose-pads to conform automatically to the contour of the nose. Ful-Vue safety goggles are patented.

The F3100 Ful-Vue goggle is fitted with the new 6-curve super armorplate lenses, capable of withstanding blows approximately twice as heavy as those which fracture standard lenses. The domed surface of the lens is declared to be exceptionally effective in deflecting glancing blows. Lenses are shaped to fit closely to the eye without interfering with eyebrows or lashes.

Problem No. 4—Correct Layout



Solution of "Transition Piece" practice problem, which appeared on page 186 of the July issue



Problem No. 6—For Readers to Lay Out

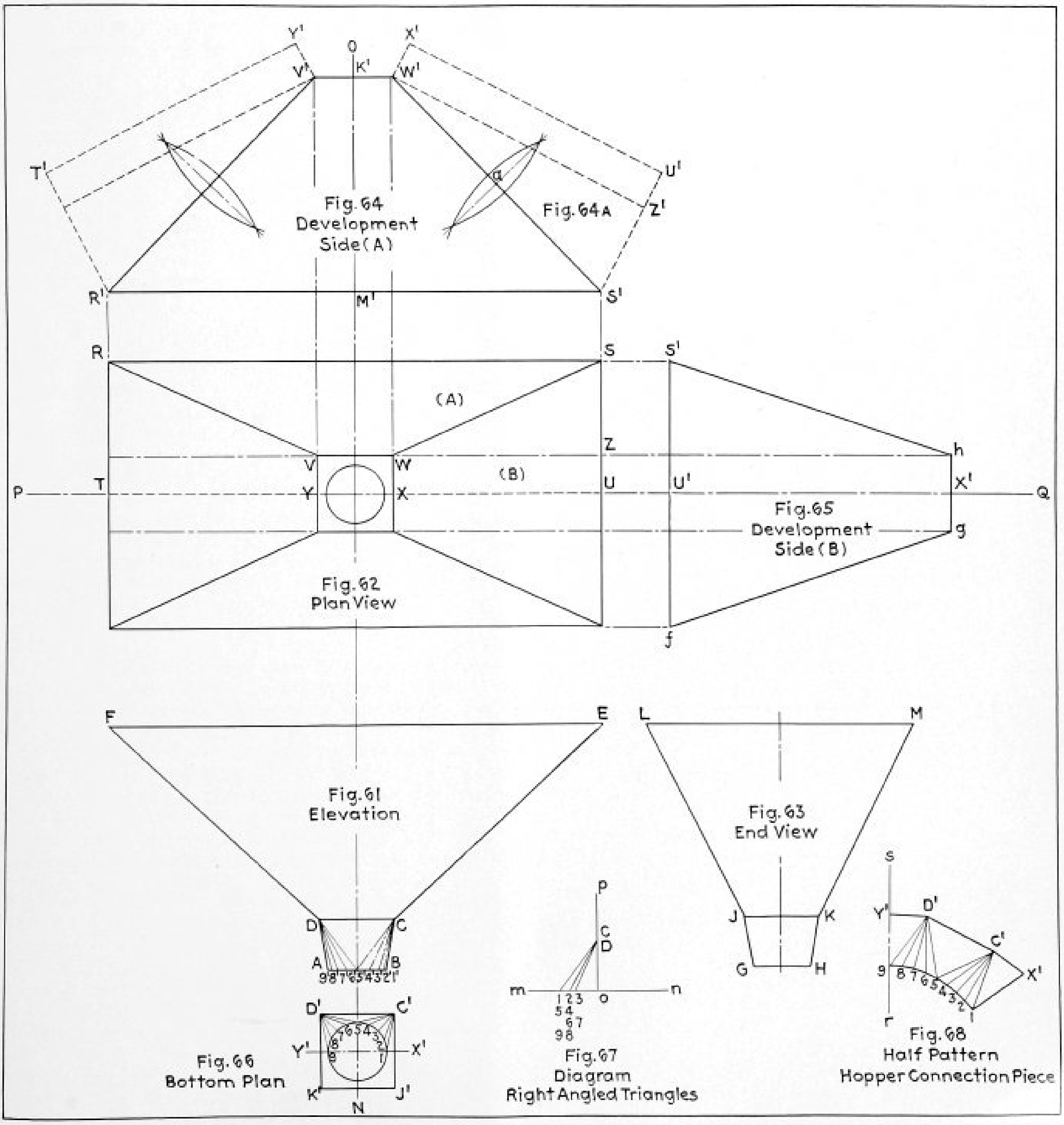
Practice Problem No. 6, shown herewith, is intended to demonstrate the principles of layout described in the present instalment of "Practical Boiler Development." The reader should study the methods employed in developing the hopper and try his hand at the practice problem. The correct layout of this problem will be illustrated in the December issue.

PRACTICAL PLATE DEVELOPMENT—VII

Hoppers

By George M. Davies

Hoppers of all shapes and sizes are used for the handling of ores, sand and gravel, etc. The conventional type has a rectangular-shaped top and bottom with a con-



Detailed development of rectangular hopper and connection piece nection piece tapering to a round outlet as illustrated in Figs. 61 to 63.

Fig. 61 shows the elevation, Fig. 62 the plan view and Fig. 63 the end view of the hopper to be developed.

It will be noted that the center line *P-Q* divides the plan view into two symmetrical halves, also the center line *N-O*, and for this reason it will only be necessary to develop one side as *A* and the front as *B*. The opposite side and the back are duplicates of these patterns. However, where the center lines do not divide the plan into symmetrical halves, it is necessary to develop all four sides of the hopper.

To develop the side *A*, Fig. 64, step off on the center line *N-O* the distance *K'-M'* equal to the distance *M-K* of the end view, Fig. 63 as shown. Draw lines parallel to *R-S* through *M'* and *K'*. Parallel to the center line *N-O* draw lines through the points *R* and *S*, cutting the line just drawn through *M'*, locating the points *R'* and *S'*, Fig. 64. Then parallel to the center line *N-O* draw lines through the points *V* and *W*, cutting the line just drawn through *K'* locating the points *V'* and *W'*, Fig. 64. Connect the points *R'*, *S'*, *V'*, *W'* completing the pattern of the side *A*.

Develop the side *B* in the same manner, as shown in Fig. 65, making the distance *U'-X'*, Fig. 65, equal to *C-E*, Fig. 61.

For small rectangular hoppers, it is sometimes desirable to have the seam along the center line *P-Q* as *T-Y* and *X-U* in the plan view, making the side and one-half the front and back in one piece, the development is shown in Figs. 64 and 64A.

Develop the side Fig. 64 as already illustrated, then bisect the line *W'-S'* finding the center (*a*), Fig. 64A, and with (*a*) as a center and *a-S'* as a radius, scribe an arc. With *S'* as a center and with radius equal to *S-Z*, Fig. 62, scribe an arc cutting the arc just drawn, locating the point *Z'*.

Then erect perpendiculars to the line *W'-Z'* at the points *W'* and *Z'* and on the perpendicular to the point *Z'* step off *Z'-U'* equal to *Z-U*, Fig. 62. On the perpendicular to the point *W'* step off *W'-X'* equal to *W-X*, Fig. 62, locating the points *U'* and *X'*, Fig. 64A.

In like manner develop the half of the back as shown, completing the half pattern of the hopper as shown by the lines *Y'-V'-W'-X'-U'-S'-R'-T'-Y'*.

To develop the pattern of the connection piece, draw the bottom plan view, Fig. 66, as shown.

Divide the semi-circle *X'-Y'*, Fig. 66, into any number of equal parts, eight being taken in this case; the greater the number of equal parts taken the more accurate the final development. Number the points from *1* to *9* as shown. Connect the points 1 to 5 with *C'* and 5 to 9 with *D'*.

Parallel to the center line *N-O* draw lines through the points 1 to 9 cutting the line *A-B*, Fig. 61, locating the points 1' to 9'. Connect the points 1' to 5' with *C*, Fig. 61, and the points 5' to 9', with *D*, Fig. 61. These lines are the surface lines of the connection piece, the true lengths of which must be determined in order to develop the connection piece.

To determine the true length of the surface lines, it will be necessary to construct a series of right angle triangles as shown in Fig. 67.

On any line as *m-n*, Fig. 67, erect a perpendicular at any point as *o-p*. On *o-p* step off *o-C* and *o-D* equal to the vertical distance between the lines *A-B* and *C-D*, Fig. 61. Next on the line *m-n* step off from *o* the distances *C'*-1, *C'*-2, *C'*-3, *C'*-4, *C'*-5 and *D'*-5, *D'*-6, *D'*-7, *D'*-8, and *D'*-9, Fig. 66, locating the points 1 to 9 Fig. 67. The line *C*-1, Fig. 67, will be the true length of the surface line *C*-1', Fig. 61, and line *C*-2, Fig. 67, will be the true length of the surface line *C*-2', Fig. 61, etc.

Before developing the pattern of the connection piece, it will be noticed that the center line *X'-Y'*, Fig. 66, divides the bottom plan into two symmetrical halves and therefore a pattern of one half can be duplicated for the other half.

To develop the half pattern of the connection piece, draw any line as *r-s*, Fig. 68, and on *r-s* step off the distance *Y'*-9 equal to the distance *A-D*, Fig. 61. Then with *Y'*, Fig. 68, as a center and with a radius equal to *Y'-D'*, Fig. 66, scribe an arc; then with 9, Fig. 68, as a center and with a radius equal to 9-*D*, Fig. 67, scribe an arc cutting the arc just drawn, locating the point *D'*, Fig. 68. Then with 9, Fig. 68, as a center and with a radius equal to the distance 9-8, Fig. 66, scribe an arc; then with *D'*, Fig. 68, as a center and with a radius equal to *D*-8, Fig. 67, as a radius scribe an arc cutting the arc just drawn, locating the point 8, Fig. 68. Continue in this manner using the distances 8-7, 7-6, 6-5 from Fig. 66 and the distances *D*-7, *D*-6, *D*-5 from Fig. 67 as shown, completing the pattern to the line *D'*-5, Fig. 68. With *D'* as a center and with a radius equal to *D'-C'*, Fig. 66, scribe an arc; then with the point 5, Fig. 68, as a center, and with a radius equal to *C*-5, Fig. 67, scribe an arc cutting the arc just drawn locating the point C', Fig. 68.

Continue as before using the distances 5-4, 4-3, 3-2, 2-1 from Fig. 66 and the distances *C*-4, *C*-3, *C*-2 and *C*-1 from Fig. 67. The distance *C'-X'*, Fig. 68, is taken equal to *C'-X'*, Fig. 66, and the distance 1-*X'*, Fig. 68, is taken equal to *B-C*, Fig. 61.

Connect all the points thus obtained completing the half pattern of the hopper connection piece.

The outline shown in the elevation, plan and end view is taken on the neutral axis of the plate, also the patterns do not make any provision for seams either riveted or welded.

(*To be continued*)

German Production of Steam Boilers

Increased activity in the German steam boiler industry during 1934 is revealed in a report from Vice-Consul James H. Wright, Cologne, made public by the Commerce Department.

Production at the end of the year was approximately 60 percent in excess of that recorded at the close of 1933, it is stated. The greater part of the industry's output went to cover domestic demand. While total production slightly more than doubled, domestic sales trebled. Exports showed a slight increase, having aggregated 4993 metric tons valued at 3,661,000 reichsmarks (2.48 reichsmarks equal $1.00 at present exchange), compared with 4001 metric tons valued at 2,971,000 reichsmarks during 1933. German foreign sales of steam boilers during the first half of the current year amounted to 1923 metric tons valued at 1,280,000 reichsmarks, compared with 1831 metric tons valued at 1,508,000 reichsmarks during the corresponding period of 1934.

While a notable improvement has occurred in conditions affecting the steam boiler industry during the past two years, the outlook is by no means optimistic, the report states. It has been estimated that present production capacity cannot be utilized at a rate of more than 60 percent. Returns are reported to be so low that they scarcely cover production costs. Increased sales volume alone will not relieve the situation. Ways and means must be found to liquidate the excessive production capacity, and in this manner to lower production costs.

Boiler Making in the Old Days

By William F. Campbell

It was in October, 1881, that I started to learn the mysteries of the art of boiler making and I'm still learning. It was at that period when boiler making was going through the transition from iron to steel. The iron plates used in the shop at that time had titles to designate the quality, such as, "tank," "shell," "C. H. No. 1," (which being decoded means charcoal iron No. 1) "flange," and "firebox."

Sometimes the boiler shells would be made throughout of the brand called flange, and sometimes of the quality known as firebox. As no plates were flanged by mills at that time, the plates that required flanging were of either flange or firebox quality. Occasionally we would have a plate of lowmoor iron in the shop, this was of exceptional quality and would be used on some difficult work, where intricate flanging was required.

The flue boiler had gone by at the time I entered the shop and the so-called multi-tubular boiler was in demand. The shop where I started did not have at the time of my beginning any power rolls to shape the plates with, but a set of hand rolls that had a capacity width of only 72 inches. There was no plate planer, and all chipping of plates was done by hand.

The men that did the chipping in those days certainly were experts. When it came to the manipulation of the hand hammer, necessity required that they should be able to use the hammer in either hand and they certainly had acquired a science that is a lost art today in the boiler shop. Pneumatic tools for chipping and riveting did not make their appearance in this zone until the later '80s or the early '90s.

The plates were quite narrow as compared with present day plates and usually two plates were required to make one course. The riveting was done mostly by hand with special hammers the design of which resulted from many years experience. When the riveting was done on the side, the hammers were shorter in the head than when it was done by the blows falling vertically upon the rivet. The hammers used for down handed work were heavier than the side hammers.

Flange turning was all done by hand, and a good flange turner was a valuable member of the shop staff. With the manipulation of iron plates, great care had to be exercised so as not to crack the plate when working against the grain. As some of the flanging was very intricate, it was interesting to see the care with which it was brought to its final shape. Great care was used in getting proper fits, as the means at hand for applying local heat, if plates did not fit, were very crude and consumed much time, which added to cost. Thus the "man at the fire" was expected to do his work in such a manner that, when fabricated in place, very little work was required before the riveters could start riveting.

The laying out of plates was an art, as the shop had a great reputation for the best class of work, and when parts were fitted in place the holes had to match or else the air was blue. The rolling of the plates as already stated, was done by hand, the rolls being of the pyramid type, that is, the two lower ones were on the same horizontal plane and the top one was tangent to the other two. Power was applied by means of two capstan wheels, one attached to one of the lower rolls and the other to the top roll. The handles on the "motive power" were about 4 feet long, and the men would get out on the end of these and heave and keep on heaving until the plate was bent to the required shape. There were usually six handles to each wheel.

Our shop did not use many rivets over 7/8 inch in diameter, but it certainly was a pleasure to watch a good gang of riveters at work. Four men made up the gang, two riveters, a holder-on or as some preferred to call him the bucker-up and the last but by no means the least the rivet boy.

The forge for heating the rivets had a hearth about 22 inches square and about 8 inches deep. It was mounted on a pair of wheels to facilitate moving it about. At one end was the tuyere, into which was inserted the blow end of a 24-inch blacksmith's bellows that was mounted in a frame and operated by a long lever handle. It was quite cumbersome but very efficient, and could be wheeled up to the end of the shell or close to the work where the rivet was required. This was the first task assigned to a new arrival to learn all the technique of the exacting science of boiler making. But the "music" of the riveting hammers was by no means doleful nor depressing, it had an uplifting effect that one who has ever heard it can never forget. It had a rhythm and cadence that required no metronome, each blow delivered with the right amount of force and so well directed that it was delivered with the minimum of error at the spot intended. It was nice work—it was good work.

Of course there were some mechanical riveting machines in use at this time in some of the large shops, but many of the shops depended upon the hand riveters. Even with the machine there were always a great many rivets that had to be driven by hand.

After riveting came the chipping and calking. The chipping had to be done with some idea of straightness and evenness; the bevel kept within a reasonable degree of symmetry; and above all, care had to be exercised not to mar or score the adjacent plate with the corner of the chisel. Then followed the calking. The sharp tool was very much in vogue in my early days and in the hands of a skilled calker did excellent work, but, due to careless manipulation by some, the round nose calking tool of the present day came in to use. I was told that this tool was at one time patented but never was interested enough to verify the statement. The rivet boy had to have a care that he heated the rivets to the satisfaction of the riveters; they must not be too cold, nor overheated so as to prevent them being inserted in the hole quickly; the holder-on must be snappy, get on the rivet while it was hot and take care that it was not driven back out of the hole so as to form a collar and prevent it from coming up against the sheet as it should be. He was also required to hold the head level and not have it jamb down on one side and give the work all the appearance of carelessness. The gang had to work as much in unison as a vocal quartette and the music was sweet.

There were many hard and difficult jobs but this was a part of the game. When there were large heads to dish at the fire, the whole hearth had to be cleaned out (about 6½ feet in diameter) the fire lighted and the flat circle, say 80 inches diameter and ½ inch thick, lifted onto the fire. When heated it was drawn off the fire over a hole in the ground that had been dug out saucer shaped, and then the circle was driven down into the mold with huge mauls (we called them mallets). Of course during the process many dents were put in the plate and these had to be worked out with the flatter and sledges. This was the kind of sport that put pep into one and made one's muscles stand out like iron bands, as we are told of in Longfellow's "Village Blacksmith." No punching bag was ever needed in the old-time boiler shop, but many a hard knock was given. Try and imagine with your 1935 cinema doing this work during the months of July and August. Eventually the mill did most of the flanging and dishing so that this part of the hard labor was eliminated although at times now it is necessary in repair work to resort to the "former on the ground."

There are, of course, bright spots in the old-time shop that do not appear in the sad tale already told. True the hours were long, ten hours a day and nine on Saturdays. But as we rivet boys gathered around the fire during the noon hour and listened to the tales that were told, of the battles fought and won, it really did make life worth while. The old-timers of that day would take hammer in hand and show just how they did it. All of which brings back memories in our later years, as we read Goldsmith's "Deserted Village" and learn how

"The broken soldier, kindly bade to stay,
Sat by his fire, and talk'd the night away,
Wept o'er his wounds or, tales of sorrow done,
Shoulder'd his crutch and show'd how fields were won."

I have told enough; possibly it may cause some old-timer to smile. Their ranks are becoming thin like the old guard, and it may cause the "modern" to wonder what it is all about. But nevertheless this is my story.

Power Boiler Accidents

Among serious power boiler accidents the following have recently been described in *The Locomotive*, published by the Hartford Steam Boiler Inspection and Insurance Company:

Three men were killed and three were injured by the explosion on February 11, 1935, of a horizontal tubular boiler operated by a Georgia cooperage company. The exploding boiler was demolished, as were the setting of an adjacent boiler, the boiler shed and fuel house. Two smokestacks were blown down and several adjacent buildings damaged to some extent.

Just prior to the explosion, according to employes, the steam gage showed a pressure close to 200 pounds, which was nearly twice the approved pressure. The boiler tore itself to pieces, parts of it traveling 700 feet. The shock and noise were reported as having been noticed several miles distant.

The three men who were killed and two of the injured were working near the boiler, and the other injured man, lived nearby.

In this explosion, the shell flattened out, sending other parts of the boiler in all directions. A boiler in the background was dented and some of the tubes were bowed.

Two Men Die Following Boiler Mishap

When a 5-inch circulating tube between the lower drum of a bent-tube type boiler and a water back pulled loose from the drum on March 21, 1935, at an Indiana plant, two men who sought to leave the boiler room were fatally scalded. They were working on another boiler about 100 feet away from the circulating tube and tried to get out of the building in the confusion following the release of the steam. Besides injuring the men, the accident resulted in damage to the water back and the overheating of some of the tubes. However, an alert boiler room crew was successful in drawing the fire before the rapidly draining boiler was damaged more seriously.

The automatic non-return valve on the damaged boiler functioned immediately after the accident and prevented four other boilers which were under pressure from emptying themselves into the damaged unit. In the excitement, all of the boiler feed valves must have been shut at one time and the feed pumps continued in operation. Because they were not able to relieve themselves through their safety valves, a momentary excessive pressure was built up and cracked one of the cast iron headers on an economizer.

Boiler Blast Destroys Mill

A Mississippi hardwood mill was completely destroyed when its boiler blew up some weeks ago. Attention was called to the boiler by its safety valve blowing. As the negro fireman went to attend to the boiler, it exploded, killing him instantly. Overheating and rupturing of the fire sheet because of low water was given as the cause of the accident.

The owner of a West Virginia sawmill was killed and three men were injured, one of them seriously, when a sawmill boiler exploded early in April, according to a newspaper account. The body of the man who was killed was hurled about 100 feet.

Special Advanced Welding Course Offered in Cleveland

Beginning August 26, a special five-day course in welding engineering has been offered in Cleveland by the John Huntington Polytechnic Institute in co-operation with The Lincoln Electric Company. The course, being repeated at this time due to increased activity in the welding industry and in answer to a demand for an intensive advanced welding training course, will be conducted once each month, except during November, through May, 1936. Engineers, welding supervisors and foremen will have an opportunity to engage in intensive study of both the practical and theoretical sides of arc welding. In view of the great interest in past sessions of this course, a full enrollment is anticipated for each of the weekly periods.

The course will consist of day and evening sessions. Day sessions will be held between 10:30 A. M. and 4:30 P. M. at the plant of The Lincoln Electric Company, Cleveland, which has offered the facilities of its welding school under the direction of A. F. Davis, vice-president. Evening sessions at the John Huntington Polytechnic Institute between 7:30 and 9:30 will be devoted to lectures and discussions.

The purpose of the course is to study the arc-welding process and its applications to design and fabricating problems. The process will be considered from the arc to the finished product. The following subjects will be covered: Value and use of the electric arc; calculation and distribution of stresses in welded joints; study of polarized light and rubber weld models; penetration; designing for arc welding; estimating welding costs; and organizing the welding department.

This five-day course is not to be confused with the Lincoln Welding School, which has been in regular session since it was first inaugurated in 1917. The Lincoln Welding School is probably the largest of its kind in the world and provides welding operators thorough training in all aspects of electric welding.

Complete information on the five-day course is available from E. W. P. Smith, Welding Engineering Department, John Huntington Polytechnic Institute, Cleveland.

Mobile X-Ray for Pressure Vessel Examination

With high pressures for boilers, oil cracking stills, etc., coming to be the rule rather than the exception, a great increase in the production of welded and forged pressure vessels is being realized. For the critical inspection of welds, the X-ray is rapidly being adopted as the method of choice, not only because it is a non-destructive method of examining every inch of weld but also because it is extremely practical of application and economical.

The great weight of some of these vessels makes it almost necessary to have some method of moving the X-ray apparatus, rather than the vessel, so that inspection can be made of the entire length. A large manufacturer of this class of equipment has recently purchased a General Electric X-ray unit, Model KXC-1, mounted on a Baker truck.

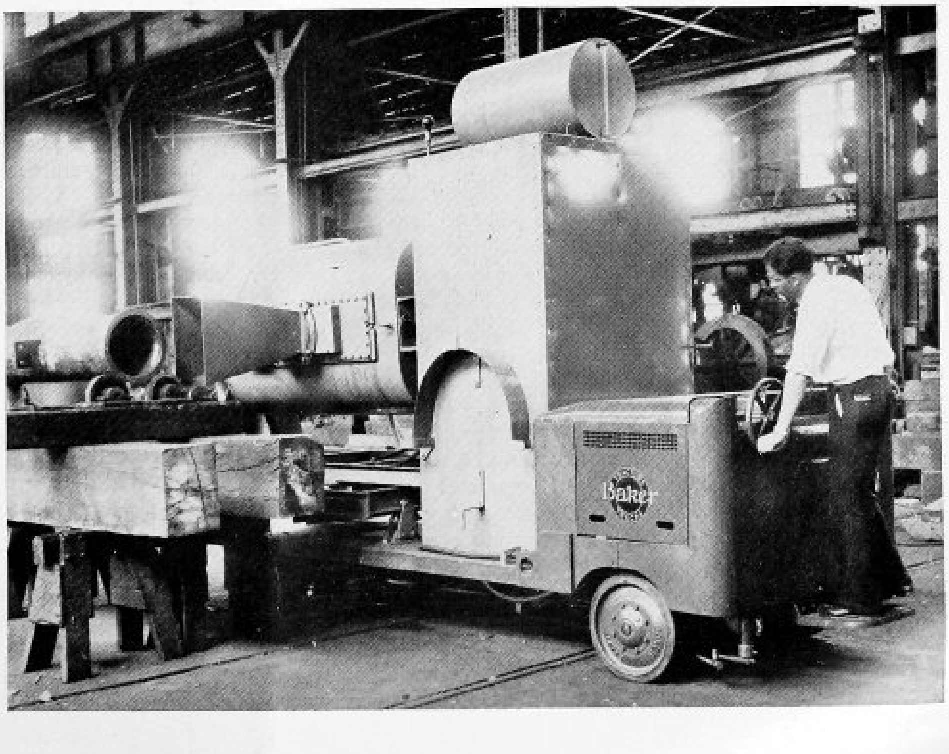
Although this X-ray equipment operates at 300,000 volts and 10 milliamperes, it is 100 percent safe against electric shock, due to the fact that the maximum voltage outside the sealed and grounded head is 220 volts in the insulated cable from the mains. The X-ray tube head is practically universally adjustable to facilitate positioning in relation to the subject under examination. The exposure time is automatically controlled by a magnetically operated shutter, and the machine is capable of producing radiographs of Class 1 pressure vessels of 4-inch rolled steel.

The motive power of the Baker truck upon which this equipment is mounted is used only to carry it the full length of the vessel being examined. Due to the roughness of the floors and in view of affording the maximum protection to the X-ray apparatus itself, it was decided that it would be a much more satisfactory operation to have the entire X-ray equipment and truck carried from one job to another by means of the overhead crane. As the X-ray equipment weighs in the neighborhood of 6¼ tons, the design of the truck presented a real problem to the engineers of the Baker-Raulang Company, especially as the allowable deflection in the center of the frame of the truck was limited to ⅛ inch in order to eliminate all possibility of throwing the X-ray out of alinement.

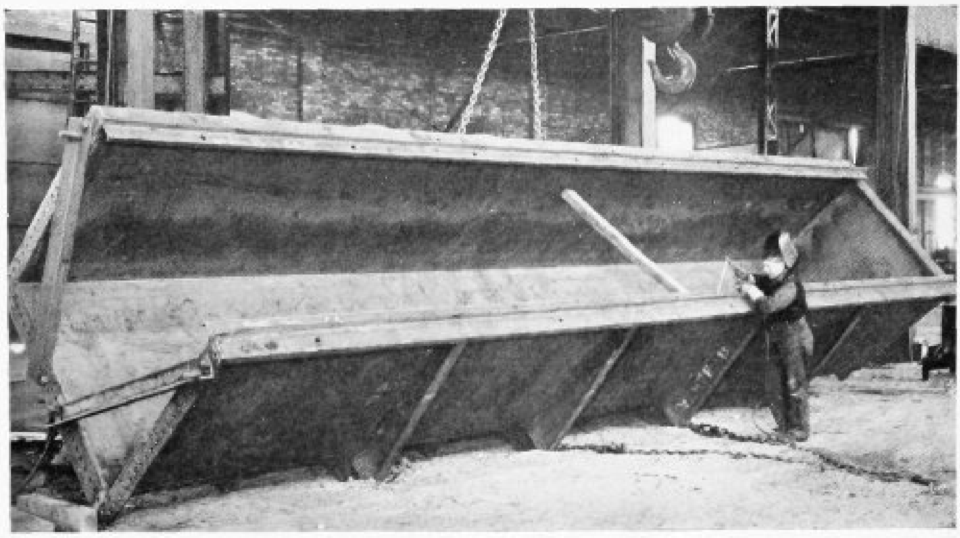
As built, the truck has a wheelbase of 116⅝ inches and a platform 138 inches long by 60 inches wide provided with alloy steel hold-down bolts to fasten the equipment. The main frame is composed of two 8-inch nickel steel I-beams with cross members of the same material, which keeps the deflection within the desired limits. The standard Baker duplex compensating suspension of the power axle and a spring-mounted trailing axle insulate the platform from road shocks and keep the X-ray steady during the traverse from one end of the vessel to the other. A five-speed controller is provided to permit accurate control of the speed of the truck and to permit starting without jerks.

Arc Welded Pickling Tanks

Two modern developments—one the vulcanizing of rubber to steel, the other welding by the electric arc—now make it possible to replace wood with steel in con-



General Electric X-ray equipment mounted on Baker electric truck for use in examining welded pressure vessels



Arc welding used in construction of pickling tank, to which a lining of rubber has been vulcanized

struction of pickling tanks at the plant of the Standard Boiler and Plate Iron Company, Niles, O. Rubber protects the steel shell from acid corrosion, arc welded construction provides a smooth, even, permanently tight surface for attaching the rubber lining.

The tanks, half of one of which is shown in the accompanying illustration, are 60 feet long, 8 feet wide, with a depth varying between 4.5 feet at one end to 5 feet at the other. A number of these tanks are being fabricated for the Wean Engineering Company, Warren, O., which is installing several of the largest continuous strip pickling lines that have ever been built.

Approximately 1300 feet of welding was required in joining the 108 separate pieces of steel used in construction. The tank was built in two identical sections, with sides, bottoms and ends completed separately and then welded together. The plating of the tank is 3/8 inch thick. After the tank was completely assembled it was sandblasted and then lined with rubber by the Vulcalock process developed by the B. F. Goodrich Rubber Company, Akron. All welding was done by the shielded-arc process with equipment supplied by The Lincoln Electric Company, Cleveland.

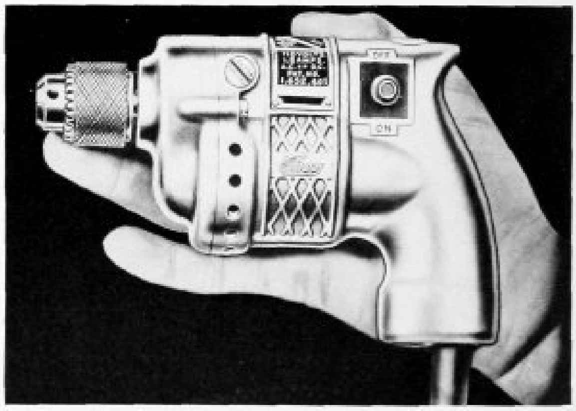
Lightest Weight Electric Drill Ever Built

The smallest, lightest weight portable electric drill ever built, weight 2½ pounds, but with the same power as tools twice its size, has just been introduced by the Independent Pneumatic Tool Company, Chicago. This new tool, the U-14 in the ¼-inch capacity and the U-13 in the 3/16-inch capacity, is half the size and weight of other drills of the same power, but will drill through steel ¼ inch thick in 5 seconds. It fits easily in one hand and operates with greater accuracy than larger and bulkier tools of the same power and capacity.

Highest grade ball bearings and accurately machined, heat-treated helical gears reduce noise and vibration to the absolute minimum and increase motor efficiency to the fullest degree. These same features also reduce heat generated to the lowest point possible, which is extremely important in a tool of a size where the operator's hand covers as much of the tool as in this case.

The Thor patented ventilating system provides effective cooling of the motor. This increases the power by enabling the motor to pull, without overheating, a sustained load closer to its maximum capacity than any other motor of the same capacity, but having less efficient ventilation.

This U-14 incorporates the same features which have made Thor motor design outstanding—the same hand-wound armature, the same special commutator construction, plus other newer and even more modern features of mechanical excellence.



Completely practical small-size drill

Specifications: U-14 capacity ¼-inch drilling; free speed revolutions per minute, 2500; weight, 2½ pounds; length overall, 6¾ inches; equipment, Jacobs chuck and 1 extra set of brushes; spindle offset, 1 inch. U-13 capacity 3/16-inch drilling; free speed revolutions per minute, 3750; weight, 2½ pounds; length overall, 6¾ inches; equipment, Jacobs chuck and 1 extra set of brushes; spindle offset, 1 inch.

Avery & Saul Company, South Boston, Mass., has been appointed distributors of seamless steel and Toncan iron boiler tubes for the Globe Steel Tubes Company, Milwaukee, Wis.

Opening of a new sales office at 622 Dwight Building, Kansas City, Mo., effective September 1, is announced by N. J. Clarke, vice-president in charge of sales of the Republic Steel Corporation, Youngstown, O. The new office will be in charge of Robert L. Pierce.

Locomotive repair operations speeded by

OXY-ACETYLENE WELDING AND CUTTING*

***By D. C. Reid*†**

While the oxy-acetylene process as applied to the railroad shop is still in its infancy, progress in the education of shop men and shop foremen on the majority of railroads has advanced to the point where the value of the torch as a means of effecting economy in the repair of equipment and in certain fabricating operations is fairly well understood. However, constant development of the art makes it imperative that this campaign of education be continued in order that full advantage may be taken of improvements in equipment, materials and procedures which are constantly being introduced.

In considering the relative merits of various processes available for the completion of repairs, ultimate economy is, of course, the controlling factor. In other words, both the cost and quality of the repair operation must be considered in order that final economy may be rightly determined. A part repaired at relatively low cost which subsequently fails or does not give the expected service does not contribute to economy but on the contrary makes for higher ultimate costs. It is, therefore, necessary in choosing between the various methods affecting detail repairs to determine not only the cheapest method of doing the original work, but also the length of service which may be expected from the repaired article in order that that procedure may be selected which will yield the greatest ultimate economy.

The locomotives which come to the shops for repairs are of numerous types and classes. Further they are used in various classes of service and under widely varying conditions, all of which means that the individual items of equipment when received for repairs are in highly variable condition and it is, therefore, possible only in the most general way to plan repair operations in advance of delivery to the shop. As a general rule the repairs to be made to any item of equipment are determined largely by a detailed inspection made after the locomotive or car has been delivered to the shop and plans for repair can only be made after such inspection is complete.

The stripping of either locomotives or cars in preparation for repairs presents the first opportunity for the economical application of the oxy-acetylene process. In present practice, the cutting torch is the most important dismantling tool and its use for this purpose insures large economies both in time and cost. In the performance of the one operation of removing fireboxes or firebox sheets which are in need of renewal the cutting torch has speeded up and helped to balance shop operations. Before the advent of the cutting torch the stock alibi for all departments when work was delayed was "waiting on the boiler makers."

At the present time, thanks to the superior speed of the cutting torch the boiler makers are able to get the jump on the machinists and to complete their work in such time that total days in shop for engines requiring new fireboxes or heavy boiler work have been greatly reduced.

The same thing applies in greater or lessor degree to all of the stripping operations. It is no longer necessary for the strippers to spend hours in drilling or shooting refractory bolts or in removing frozen nuts and the whole dismantling operation has been speeded up to the point where many hours of time are saved in getting the equipment to the point where actual repair operations can be started.

In the use of the cutting torch for dismantling operations it is necessary, however, to avoid the destruction of usable material the cost of which would outweigh the economy between cutting and removing by other methods. In order to avoid the destruction of usable parts it is necessary that the inspector or foreman determine in advance where the cutting torch should be used and where other methods of removal should be employed. As a general proposition it may be said that parts which are not to be replaced can be more economically cut with the torch than removed by other methods.

While the economies resulting from the use of the cutting torch in stripping locomotives preparatory to the completion of general repairs is a spectacular operation from which large savings per unit of equipment are secured, the use of the same torch in speeding up and reducing the cost of running repair operations is a no less important application.

The removal of staybolts or flues in small lots or in scattered positions is not only economical from a cost standpoint but materially reduces the time each engine must be held out of service for repairs. Equally valuable is this method of cutting bolts, nuts and other fastenings when the removal of machinery parts is required.

The modern engine house which is not equipped with facilities for flame cutting is badly handicapped in the requirement of keeping power moving at the least possible cost and with the greatest feasible dispatch.

Another very important field in which the cutting torch is predominant is in the dismantling of obsolete equipment which has been written off the books and is to be sold as scrap, and in the reduction of all metal scrap to charging-box or furnace size, in which condition it commands the highest market price.

A differential always exists between the market price of cut and sorted scrap and uncut miscellaneous scrap which more than covers the cost of handling and cutting and provides a margin of profit. The railroads which cut their own scrap to proper sizes for use by the steel mills and sort it into the required grades realize a substantial profit by so doing.

The introduction of the oxy-acetylene welding process

* Excerpts from a paper presented before the thirty-fifth annual convention of the International Acetylene Association.

† General superintendent of motive power, Boston & Maine.

has made it possible to repair by welding cracks or fractures or by building up worn surfaces and to continue in service large quantities of material which it was previously necessary to scrap and replace with new parts.

Locomotives undergoing repairs are in the shop for periods of from a few days to several weeks and the welding and machining of parts for replacement can be accomplished in such time as not to delay the procedure. In the larger shops it has been found advisable to set aside a bay or section where all movable parts requiring welding or building up are sent and where a crew of welders equipped with the necessary tools and facilities are provided to perform the welding operations. Such an arrangement insures maximum economy by the elimination of any lost time by the operators in moving from point to point about the shop and also makes supervision of welding operations more effective as the foreman in charge has the work under his immediate observation at all times. There are, of course, numerous welding operations which must be done on the erecting-shop pits.

Another important application of the oxy-acetylene process is in the heating of parts to be bent, straightened or laid up. By the use of the ordinary welding torch it is frequently economical to make bends in pipes at the time of their application and to take heats on running-board or other brackets to secure proper alinement, thereby eliminating the time otherwise required for mechanics to travel back and forth from the blacksmith or pipe shop to the erecting shop. Either the ordinary welding torch or a special heating torch is also a time and money saver in the laying up of firebox sheets or patches and in straightening parts on locomotives and cars which would otherwise require removal and handling through the blacksmith shop.

Up to the present the oxy-acetylene processes have been used almost entirely in connection with repair operations and relatively little has been done in the way of developing their possibilities in fabrication and construction. One exception to this general statement is found in the use of the automatic shape-cutting machine in the manufacture of certain locomotive parts.

The cutting machine, together with its appurtenant preheating and normalizing furnace, effects economies in the manufacture of a large number of equipment parts ranging from piston nuts and rod collars to heavy locomotive frame sections, guide yokes and multiple plate cutting.

In order to secure the maximum economies which are possible through the employment of the oxy-acetylene welding and cutting processes it is necessary that competent attention be given to the provision of the most efficient facilities and equipment. In shops of such size as require the continuous employment of a number of welders and cutters the distribution of the gases to points of use about the shop is most economically effected through the use of piped distributing systems.

The selection of the proper welding rods for each class of work is a further important factor. In the early days of autogenous welding many failures occurred and much unsatisfactory work was turned out due to the fact that the necessity for providing filling material of proper specifications was not fully understood. During recent years the development of suitable rods for welding any of the common materials of equipment construction has been given competent attention by qualified metallurgists and at the present time it is possible to secure a suitable rod for welding any of the metals in ordinary use. The cost of the filling metal applied in a weld is ordinarily an insignificant part of the total cost of performing the job and too much emphasis cannot be placed upon the statement that the use of suitable rods for each operation should be insisted upon even though the cost of such special rods may be a few cents higher per pound than the price of inferior quality material.

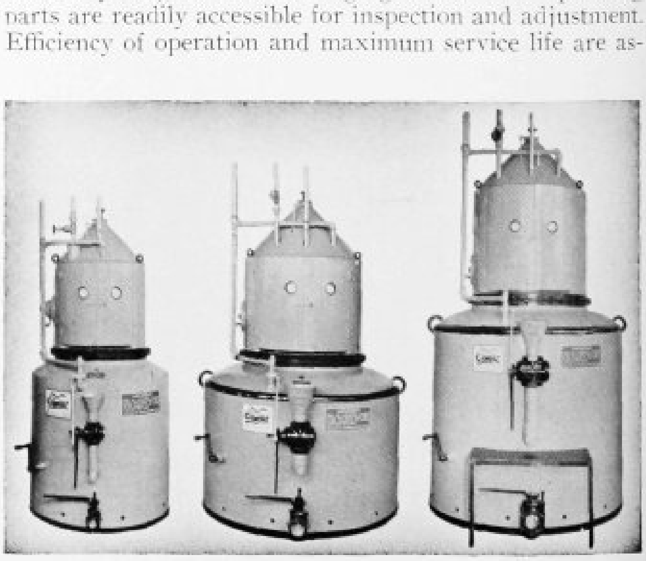
As has been previously pointed out ultimate economy rather than first cost is the important item and the selection of materials for the making of welds should be based upon the service life which the welded or built-up part will give rather than upon the first cost of the filling material.

Medium Pressure Acetylene Generators

The Linde Air Products Company, 30 East 42nd Street, New York, announces a new three-member family of acetylene generators of the medium pressure type for stationary service. These generators, designated as Oxweld Type MP-5, have a carbide capacity of 150 pounds, 300 pounds, and 500 pounds respectively, with acetylene generating capacities ranging from 300 to 1000 cubic feet per hour. The three generators provide users of the oxy-acetylene process with a range of choice that should fit practically every need for a stationary generating source of medium pressure acetylene. Except for slight differences in design, making each generator better adapted to the operating conditions for which its size makes it suited, all three generators resemble each other in essential details.

Each generator has all controls protected by a housing which can be padlocked, if desired. This will prevent unauthorized persons from operating the generator or tampering with it. The gravity type feed control unit is self-contained and is bolted to the inside of the upper section of the generator. Withdrawal of acetylene gas in operation actuates a diaphragm type feed control which causes a feed valve to open. The diaphragm is sensitive to slight changes in pressure and the carbide is released evenly in just the amount needed to maintain a constant pressure.

Rapid emptying and recharging are made possible by three features. One is a large lubricated plug valve for draining the carbide residue. Another is a water filling valve of similar construction. The third feature is an unusually large carbide charging door. All operating parts are readily accessible for inspection and adjustment. Efficiency of operation and maximum service life are as-



Acetylene generators for stationary service sured through improved design and through the use of strong, durable materials of construction.

Master Boiler Makers Meet in Chicago

The program arranged for the two-day business meeting of the Master Boiler Makers' Association, to be held at the Hotel Sherman, Chicago, September 18 and 19, is as follows:

First Day

WEDNESDAY, SEPTEMBER 18, 1935

Registration .... 7:30 to 9:30 A.M.
Business session .... 10:00 A.M.
Meeting called to order .... 10.05 A.M.
Invocation
Annual Address:
Kearn E. Fogerty, president of the Association
Routine Business:
Annual Report of the Secretary, Albert F. Stiglmeier
Annual Report of the Treasurer, William H. Laughridge
Address:
John M. Hall, chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission
Miscellaneous Business:
New Business
Appointment of Special Committees to serve during meeting
Resolutions
Memorials
Announcements
Law
Recess.

AFTERNOON SESSION

Registration .... 1:15 to 1:45 P.M.
Meeting called to order .... 2:00 P.M.
Committee Reports on Topical Subjects:

No. 1. "Boiler and Tender Tank Corrosion and Pitting, in Service and in Storage." Committee: J. C. Callahan, general boiler inspector, Chicago, Great Western Railroad Company, chairman; Edward J. Reardon, service engineer, Locomotive Firebox Company; A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific Railroad Company.

No. 2. "Fusion Welding As Now Applied to Boilers and Tenders." Committee: Ira J. Pool, district boiler inspector, Baltimore & Ohio Railroad System, chairman; Leonard Ruber, superintendent boiler department, Baldwin Locomotive Works; H. H. Service, general boiler inspector, Atchison, Topeka & Santa Fe Railway Company.

Announcements.
Recess.

Second Day

THURSDAY, SEPTEMBER 19, 1935

Registration .... 7:45 to 8:30 A.M.
Meeting called to order .... 9:00 A.M.
Unfinished Business .... 9:00 to 9:15 A.M.
Annual Address:
Albert F. Stiglmeier, secretary.. 9:15 to 9:30 A.M.
Special Report of the Southern Pacific Company.
"Fusible Plugs." G. H. Kurlfinke, second vice-president .... 9:30 to 10:00 A.M.
Committee Reports on Topical Subjects:

No. 3. "Staybolt Leakage and Cracking of Firebox Side Sheets—Methods of Prevention." Committee: M. V. Milton, chief boiler inspector, Canadian National Railways, chairman; C. W. Buffington, general master boiler maker, Chesapeake & Ohio Railway Company; John J. Powers, system boiler maker general, Chicago & North Western Railway Company.

No. 4. "Application and Maintenance of Arch and Watertubes with Their Maintenance." Committee: William H. Moore, general foreman boiler maker, Pere Marquette Railway Company, chairman; R. A. Pearson, general boiler inspector, Canadian Pacific Railway Company; Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis Railway.

Announcements.
Recess.

AFTERNOON SESSION

Meeting called to order .... 2:00 P.M.
Special Committee Reports ...... 2:00 P.M.
Good of the Association .... 2:10 to 2:30 P.M.
Election of Officers .... 2:30 to 3:00 P.M.
Report of Committee on Resolutions 3:00 to 3:10 P.M.
Memorials .... 3:10 to 3:20 P.M.
Committee on President's Address.. 3:20 to 3:30 P.M.
Good of the Association .... 3:30 P.M.
Adjournment.

Part Played by A.S.M.E. in New Marine Boiler Rules

The code of rules pertaining to the design, construction and inspection of boilers, unfired pressure vessels, and appurtenances thereof of the Department of Commerce, Bureau of Navigation and Steamboat Inspection, which became effective on July 1, represents the culmination of an effort to modernize marine boiler rules which had its inception in 1926. D. S. Jacobus, chairman of the Boiler Code Committee of the American Society of Mechanical Engineers, in a recent comment on the part played in the formulation of the code by this organization in co-operation with the Bureau of Navigation and Steamboat Inspection and other interested groups, outlines the painstaking manner in which this valuable contribution to the industry has been developed. The part taken by the A. S. M. E. was as follows:

Ex-President Herbert C. Hoover, when Secretary of Commerce, sponsored the American Marine Standards Committee, which, among other assignments, was to prepare rules covering the construction of marine boilers. The American Society of Mechanical Engineers was invited to co-operate. The invitation was accepted and the Boiler Code Committee appointed what was later known as the Special Committee on Marine Boiler Rules.

At a meeting of the subject subcommittee of the American Marine Standards Committee on "Rules for Boilers and Pressure Tanks," held March 31, 1926, the Hon. Dickerson N. Hoover, then supervising inspector general of the Steamboat Inspection Service, made it plain that the Service wished to adopt rules that would be thoroughly up to date. He suggested that a review be made of all established codes, with the idea of preparing a set of rules which would be the best of all, and that an endeavor be made to have the law modified, if found necessary, to permit adoption by the Steamboat Inspection Service of these rules as a whole.

The American Marine Standards Committee issued a set of rules in 1929 for the design and construction of marine boilers and pressure vessels. The Boiler Code Committee, to whom this report was referred by its special committee, took the position that it should be made more complete so as to give comprehensive rules for all of the usual types of boilers employed in marine service.

In view of the fact that the code which was being prepared by the American Marine Standards Committee did not seem to meet the requirements of the Steamboat Inspection Service, the Steamboat Inspection Service prepared a tentative set of rules of its own which it submitted to the A. S. M. E. Boiler Code Committee for comments and suggestions. These rules included all types of boilers ordinarily used in marine service. The Boiler Code Committee reported that it considered the rules to be prepared along proper lines and commended the Steamboat Inspection Service for preparing a more complete set of rules.

The American Marine Standards Committee, acting through the Society of Naval Architects and Marine Engineers, petitioned the Hon. L. P. Lamont, then Secretary of Commerce, to recognize its boiler rules as the standard. At the suggestion of Secretary Lamont a committee was organized to co-ordinate the two sets of rules which had been prepared. This committee, known as the Committee to Co-ordinate Marine Boiler Rules, was formed by requesting a number of societies to appoint representatives. Capt. Walter M. McFarland, who was not originally a member of the committee, was appointed chairman. The members of the committee and the organizations which they represented were as follows: W. M. McFarland, chairman, past-president, Society of Naval Architects and Marine Engineers; H. L. Seward, secretary, Society of Naval Architects and Marine Engineers, and American Bureau of Shipping; Charles F. Bailey, National Council of American Shipbuilders; John L. Crone, Bureau of Navigation and Steamboat Inspection; D. S. Jacobus, past-president, The American Society of Mechanical Engineers; B. E. Meurk, American Steamship Owners' Association; and H. C. E. Meyer, American Marine Standards Committee. Members of the subcommittee were: J. Bergvall, American Bureau of Shipping; A. V. Bouillon, American Marine Standards Committee; and J. W. Wilson, Bureau of Navigation and Steamboat Inspection. Captain McFarland and Mr. Bouillon are now deceased.

In the formulation of the code a draft was first prepared by Mr. Bergvall and Mr. Wilson, who had the co-operation of Mr. Bouillon in a few of the early sessions.

Captain McFarland was an ideal chairman, his attitude in conducting the meetings being well expressed in the preamble which he prepared for the report of the committee, a paragraph of which reads as follows:

"A guiding principle from the beginning has been that the code should represent the unanimous opinion of the committee. In other words, if differences of opinion arose, they were to be smoothed out and settled by unanimous vote. With great satisfaction the committee can assert that this result has been accomplished."

The rules sanction the fusion-welding of drums or shells. This section was prepared by a committee on welding in marine construction of the American Welding Society, and was based on the rules prepared by the A. S. M. E. Boiler Code Committee with the co-operation of the American Welding Society.

The report of the committee was published by the U. S. Department of Commerce and issued April 15, 1933, as the First Report of Committee to Co-ordinate Marine Boiler Rules as approved by the committee. Copies of the report were sent to a number of interested parties with the request that discussion be submitted for the guidance of the committee in preparing a final draft. Mr. Wilson did most valuable work in conferring with many organizations and with experts in various fields.

The last meeting of the committee was held in New York City, August 13, 1934, in general session with the A. S. M. E. Special Committee on Marine Boiler Rules and other interested parties. At this meeting all of the questions that were still open bearing on revisions were discussed and an agreement reached regarding the way in which they should be handled.

The Hon. D. N. Hoover did heroic work in preparing and securing the passage of a bill to amend the laws relating to construction and inspection of boilers to free the Bureau of Navigation and Steamboat Inspection of certain objectionable legal restrictions and to allow the use of the more exact and consistent rules that were being prepared by the committee. This made it possible for the Bureau of Navigation and Steamboat Inspection to prepare a revised set of rules for its use based on the report of the co-ordinating committee. These rules, as already stated, have been issued as Amended Rules I and II, General Rules and Regulations of the Bureau of Navigation and Steamboat Inspection, and are a fine example of what can be done by co-operation and by enthusiastic and painstaking effort of those doing the work.

J. B. Brown Appointed Assistant Chief Inspector, Bureau of Locomotive Inspection

John Brodie Brown, who has been appointed assistant chief inspector of locomotives in the Interstate Commerce Commission, Bureau of Locomotive Inspection, was born May 25, 1881, at Montreal, Can. After a common school education he took courses in locomotive operation and mechanical engineering with the International Correspondence Schools. From October, 1900, to July, 1902, he was a fireman on the Great Northern; from July, 1902, to October, 1905, fireman on the Oregon-Washington, and from October, 1905, to January, 1912, engineer on the same road. On January 16, 1912, he was appointed district inspector of locomotive boilers of the Interstate Commerce Commission, for the district of Oregon and Washington, and he has continued in that capacity until his new appointment as assistant chief inspector.

L. R. Gurley Joins Simmons-Boardman Staff

L. R. Gurley, who has joined the Chicago advertising staff of the Simmons-Boardman Publishing Company, was graduated from the University of Pittsburgh in 1920 and from the special apprenticeship course of the Pennsylvania Railroad. He later served as a motive power inspector and in the office of the superintendent of motive power of that road at Pittsburgh, Pa. In May, 1924, he joined the editorial staff of the *Railway Age* and the *Railway Mechanical Engineer*. In September, 1929, he resigned to become editor of a new publication called *Welding*, a magazine published by Steel Publications, Inc., Pittsburgh, Pa., and from September, 1933, until December, 1934, he was western manager of the Chicago territory for that company.

Allied Railway Supply Men to Meet With Railroad Associations

The co-ordinated railway associations committee supported by the Allied Railway Supply Association, Chicago, consisting of F. P. Roesch, W. O. Thompson and T. Duffsmith, has received authority from officials of the Association of American Railroads to hold business meetings at the Sherman Hotel, Chicago, on September 16 and 17 for the Traveling Engineer's Association and the International Railway General Foremen.

On September 18 and 19 a meeting will be held in conjunction with that of the International Railway Fuel Association and the Master Boiler Makers' Association.

Fifteenth Fall Meeting of the American Welding Society

The Fifteenth Fall Meeting of the American Welding Society will be held at the Palmer House, Chicago, September 30 to October 4. A complete program of technical papers and addresses has been arranged for the five-day meeting. The meetings will be conducted by J. J. Crowe, president of the association. Technical sessions will be presided over by various members, prominent in the several branches of the welding industry.

The last day of the meeting will be devoted to visits at plants in and around Chicago engaged in metal working. Practically every phase of actual welding operations will be demonstrated during these visits.

Byers to Make Steel Pipe in Addition to Wrought Iron Pipe

The A. M. Byers Company, Pittsburgh, leaders in the wrought iron industry since 1864, have just announced to the trade the third major expansion project for this company in recent years.

Several years ago Byers completed the largest and most modern wrought iron mill in the country at Ambridge, Pa., for manufacturing genuine wrought iron under their new process. Following this, the operations were further expanded to include the reintroduction of a wide range of wrought iron products which includes plates, sheets, merchant bars, angles, structurals, and forging billets.

The third step in broadening the sales and manufacturing activities of the company was taken when J. Frederic Byers, chairman of the board, announced recently that Byers steel pipe would be manufactured in addition to the present complete line of wrought iron products. Byers steel pipe will be made in the company's modern pipe mills under the same executive supervision as exists on wrought iron pipe.

"The use of wrought iron pipe," says Mr. Byers, "for corrosive services in buildings, industrial plants, and underground lines, with steel pipe for practically all other piping requirements, materially broadens our markets. Our customers who buy steel pipe as well as wrought iron have suggested that we make a steel pipe which, within its field, would measure up to the same high quality leadership that we now enjoy in wrought iron. This development means that we can now offer our customers both steel and wrought iron pipe, thereby meeting practically all of their pipe requirements."

On July 15 the Air Reduction Sales Company moved from its long established location at 3rd and Glisan Streets to larger quarters at 13 Northwest 4th Avenue, Portland, Ore.

Trade Publications

Boiler Plant Equipment.—Combustion Engineering Company, Inc., New York, in a recent bulletin describes in condensed form all the types of boilers, complete steam generating units, stokers, pulverized fuel systems and heat recovery equipment furnished by that company. Line drawings of such equipment are included.

Testing Machine for Welded Specimens.—The delay and complexity of shipping weld specimens to testing laboratories has led to the development of a portable testing machine by the Air Reduction Sales Company, New York. This machine, which is described in a recent folder, is designed to make tensile and bend tests on the job.

Welding Electrodes.—Welding Electrodes as manufactured by the Wilson Welder & Metals Company, Inc., North Bergen, N. J., are featured in a catalogue recently issued. The subject matter treats of the metallic composition, physical properties, applications, general description and welding procedure with this type of electrode.

Alloy Sheet Steel.—The Republic Steel Corporation, Massillon, O., has issued a reprint of an article on the subject "New High Tensile Steel" by Howard L. Miller which appears in the July issue of *Metal Progress.* The article contains a fund of authentic information on this new product of the Republic Steel Corporation which promises to have a wide application where the requirement is a very high strength steel.

Hard Facing.—A complete discussion of the technique of building up worn tool and equipment surfaces by hard facing them through the medium of the welding arc is contained in a bulletin issued by The Lincoln Electric Company, Cleveland. Typical instances in which arc welding is employed at remarkable savings include the restoration of worn parts of excavating equipment, dredging equipment, crushers and other heavy machines as well as in restoring cutting edges of high-speed machine tools and making new tools of low cost alloy steel.

Rolled Steel.—Under the title "Rolled Steel for Machine Construction" the Illinois Steel Company, Chicago, and the Carnegie Steel Company, Pittsburgh, have collaborated in the preparation of a new technical booklet which constitutes a most complete discussion of a new form of steel product. For executives and production men it contains valuable suggestions on the forms of steel available; short cuts to economy in buying; how rolled steel and castings may be combined; suggestions on welding technique; stress relief, etc. Copies will be sent to any reader who applies to either company.

Tools.—A graphic index, detailed line drawings giving sectional views and complete engineering data, showing sizes and tolerances are some of the features of the new Scully-Jones No. 105 Catalogue. This publication presents a line of drilling, tapping, counterboring, reaming and milling tools, as well as a complete line of boiler tools. Considerable space has been devoted to explaining the merits and uses of these tools as well as a number of new developments in the tool industry. Copies of the catalogue may be obtained from Scully-Jones & Company, 1901 S. Rockwell Street, Chicago.

Boiler Maker and Plate Fabricator

VOLUME XXXV NUMBER 9

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BOILER MAKER AND PLATE FABRICATOR is a member of the Associated Business Papers, Inc. (A. B. P.), and the Audit Bureau of Circulation, (A. B. C.)

EDITORIAL STAFF: H. H. Brown, Editor. L. S. Blodgett, Managing Editor

Contents

Communication

Conventions Should Be Continued

To the Editor:

The editorial in the August issue of Boiler Maker and Plate Fabricator, regarding the appeal of the master boiler makers to superintendents of motive power for approval of the meeting to be held in September, should arouse interest in the general course along which railroads have been going the past fifteen years. There is one school of thought which advocates public ownership of railroads for a solution of the difficulties confronting them. I am one of another school which believes in relieving railroads of the political control to which they are subjected, substituting sensible regulations which will permit them to return to their former prosperity, enjoying the loyalty of their employes, for the benefit of the country at large as well as for some return to the stockholder.

The proponents of government ownership do not seem to have learned the lesson taught the country when railroads were operated by the government as though it owned them. This unfortunate period of political control cost $1,600,000,000 in about two years and destroyed the morale of the employees.

There was a greater fallacy which was undertaken at that time, but it did not make its impression upon the minds of the people as it should have done. That was the standardization of all parts composing the railroad, human as well as mechanical. In this the politicians had the assistance of the labor leaders.

So far as the mechanical part was concerned, the locomotive will serve as an illustration of the difficulty of having a man or a few men design a machine which will perform equally well in all kinds of service in every section of the country. Had this practice been continued over a long period of years, there would have been a continuous decline in the efficiency of railroads in every department, and the shipper would have suffered, thereby adding to the cost of living of the consumer. All initiative would have been killed; able men would have left the service, and their places taken by mediocre men who were being rewarded for being able to control votes.

It is my observation, extending over many years, that men from the mechanical departments of railroads attending conventions are anxious to learn from others what they are doing, how they are doing it and what the results are. At every convention I have attended I have seen men in serious discussion outside the meeting halls regarding economies, designs and practices. When I visit shops I am always asked by men interested in construction and maintenance of power about matters of which I have some knowledge acquired in rolling mills, from manual labor to manager, and in observations of shop practices in all sections of the country. These men are sincere, they are a great asset to the railroads, and should be encouraged instead of being frustrated in making their services of the greatest value to their employers.

Men in the shops should be given opportunities of meeting others in similar service elsewhere. Such contacts keep alive the spirit of friendly rivalry which redounds to the benefit of the railroads and to the profit of the shipper and the stockholder. Conventions should not be discontinued.

Pittsburgh, Pa. Henry F. Gilg.

National Metal Congress to Open in Chicago, September 30

Two hundred and five companies have now reserved exhibit space at the National Metal Exposition, to be held in the New International Amphitheater, Chicago, the week of September 30, W. H. Eisenman, Managing Director of the National Metal Congress and Exposition, and National Secretary of the American Society for Metals, announced today.

"This year's Exposition is already thirty percent larger than that of last year, and I have high hopes of it being the largest in the seventeen-year history of the Show," Mr. Eisenman said.

"Practically every product, process and type of equipment used in the metal industry will be displayed in the huge Amphitheater," Mr. Eisenman added, pointing out that the entire space—more than four acres—will be devoted to manufacturers' displays.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on practical boiler shop problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given special permission to do so.

By George M. Davies

Developing a Cone

Q.—Would you kindly furnish me with a simple layout for the development of a cone. R. E. B.

A.—The pattern layout for a cone requires a simple construction known as the radial method, the use of

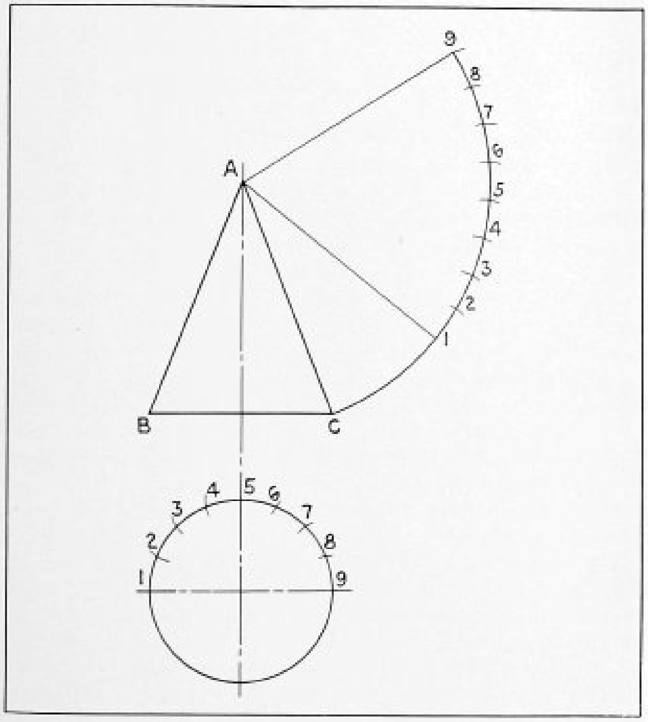

Fig. 1.—Method of developing a cone

which is illustrated in Fig. 1 for the development of a one-half pattern for the cone *A-B-C*.

Construct the elevation of the cone as *A-B-C*, with *A* as a center and with *A-C* as a radius describe an arc of indefinite length. From any convenient point, as 1 on the arc just drawn, draw a radial line connecting with point *A*, then on the arc from point 1 lay off the stretch-out for the base of the cone. This may be done with a graduated traveling wheel, or by spacing the arc as shown. The division lengths should equal the arc lengths of the plan. The circumference of the base *B-C* equals the product of its diameter multiplied by 3.1416. For example, if the base *B-C* is 10 inches in diameter, its circumference is $3.1416 \times 10 = 31.416$ inches. This length is called the stretch-out in pattern work. Having located the point 9, connect it with *A* by the radial line *9-A*, completing the half-pattern of the cone as *A-1-9-A*.

Treating Boiler Feed Water

Q.—Would you kindly inform me as to where I can get a book on the treating of boiler feed water for locomotives. B. J. T.

A.—A recent book on the treating of boiler feed water is "Boiler Feed and Boiler Water Softening" by H. K. Blanning and A. D. Rich, published by Nickerson and Collins Company, Chicago. While this book does not deal with locomotive boilers in particular, it does cover the subject of water treatment for boilers in a practical way.

Articles on the subject of water treatment for locomotive boilers can be obtained as follows: (1) "Boiler Feed Water," by J. V. Cardello, *The Baldwin Locomotive*, January 1933, Baldwin Locomotive Company, Philadelphia.

(2) "Water Treatment for Locomotive Boilers," report of A.R.E.A. Committee on Water Service and Sanitation pertaining to good practice in the treatment of feed water for locomotives, THE BOILER MAKER, August 1932.

(3) "Advantages and Disadvantages of Treated Water," *Official Proceedings* of the Master Boiler Makers Association, 1922, and later years.

Spherical Tank Layout

Q.—Will you kindly advise us if you can give us a scheme for correctly laying out plates on a spherical tank; the tank in question would be about 32 feet in diameter, made of 1⅛-inch plate and round. We have the book "Laying Out for Boiler Makers," in which the layout of a hemispherical tank head is shown, but it seems to be schematic only, and not an accurate means of developing the plate. We would be glad to have your advice, if you can give us any information regarding this problem. W. T. F.

A.—Spherical tanks of large diameter are developed in the same manner as the hemispherical head as illustrated in Figs. 4,7,9 and 10 on pages 263, 264 and 265 of "Laying Out for Boilers Makers," second edition, 1913.

Although the text is not in detail, the illustrations, Figs. 4, 7, 9 and 10 clearly indicate the procedure, when the method of developing the plates used for this type of work is understood.

On page 255 is shown a simple method of developing the plates of an hemispherical head for a tank. The procedure for developing the plates is given in detail and a thorough understanding of this method should be obtained before attempting to lay out more complicated problems.

The development of the head in Figs. 4, 7, 9 and 10 is a practical application of the method of developing the head as shown on page 255. Due to the large diameter of the head, the author has obtained the sizes of the plates by calculation rather than depending on the layout to obtain the pattern sizes.

Boiler Repair Items

Q.—I have been a reader of your magazine for more than a year. I am a welder—not a boiler maker—so get very little boiler information I can understand. I work in a machine shop and am supposed to do the boiler work which comes in.

Here are some of the problems I have in my mind:

(a) The right and wrong way to roll tubes?
(b) To bead them?
(c) Replace staybolts?
(d) Remove mud from waterlegs which have never been cleaned?
(e) When to use copper ferrule on tubes?
(f) What to do if hole is out of round so tube won't roll tight?
(g) The best way to get a flue sheet ready for a set of tubes—where previous set was welded in? C. W. D.

A.—(a) The rolling or expanding of tubes should be done with a roller expander, the tube is uniformly enlarged and its outer surface brought into solid bearing metal to metal with the entire surface of the tube hole in the sheet. The work should be done by a competent person.

Before expanding the tube, the expander should be examined to see that it is equipped with the proper rollers, straight or tapered in the proper direction. Rolling should be stopped when the rollers operate evenly all around the tube with sufficient pressure on the mandrel.

An excessive amount of rolling of tubes should not be permitted as it may cause, dangerous reduction in the thickness of the tube, expansion of the tube hole, and overstressing of the metal.

(b) The beading of a tube shall be done by rollers especially designed for that purpose or by a tapered mandrel driven into the end of the tube; on locomotive boilers beading tools illustrated in Fig. 1 and Fig. 2 are used.

The beading should be full and smooth, there should be no cracks in the bead, for if the tubes are of good quality and the beading has been done correctly the tube ends will not be injured.

The tube end should be lightly rolled after beading.

(c) The method of replacing staybolts depends greatly upon what kind of equipment and tools are at hand and where the work is to be done. Shops equipped with modern tools, oxy-acetylene cutting torches, power driven drilling machines and other jigs gotten up to expedite this work, can do it more readily and easily than those not so well equipped.

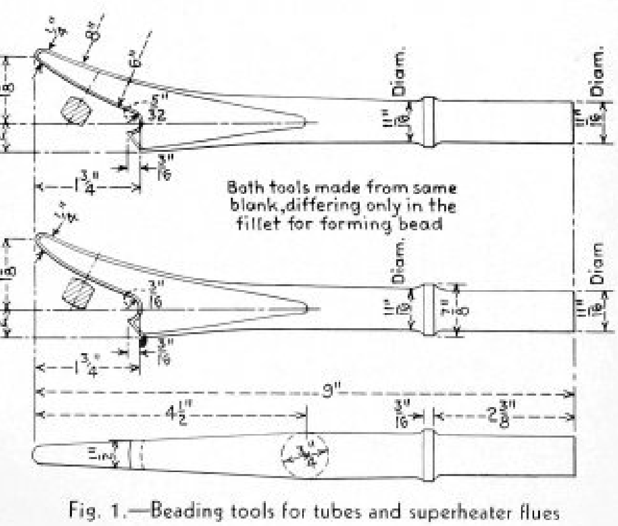

Fig. 1.—Beading tools for tubes and superheater flues

The bolts are removed either by cutting out same with an oxy-acetylene torch or by hand with a hammer and a cape chisel.

Some require that all staybolts be renewed one size larger than the bolt which was removed. This arrangement quickly enlarges the holes in the outside wrapper sheet, and, unless the holes in the wrapper sheet are reduced, the renewal of outside wrapper sheets will be rather heavy.

The proper closing of the holes in the outside wrapper

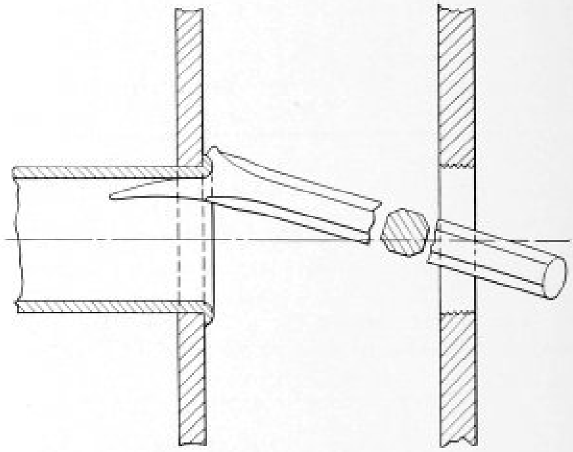

Fig. 2.—Bead over with tool similar to this one

sheet is readily accomplished by using a flat die with a long-stroke hammer and holding on the inner side as well as outside, care being taken to close only the holes enough to obtain a full size thread.

The question arises as to the largest size bolt to be applied to a side sheet. There is a difference of opinion on this subject. The smaller the bolt, the more flexible it will be, and as flexibility governs the service given by the staybolts, it is necessary then to keep the size as small as possible. Usually, when building new boilers in the first installation staybolts are 7/8 inch diameter. This practice, if within the factor of safety, will lengthen the wrapper sheet service.

Several methods of reducing the size of staybolt holes are in use at the present time; namely, bushings, solid plugs and welding. Bushings are readily made on an automatic screw machine or turret lathe, from solid bars. Where these bushings are made on an automatic machine, it greatly reduces the cost of manufacture. Bushings should be applied in the smallest possible size, so as to allow for renewal, if necessary, when the firebox is next removed.

Solid plugs, or sunflowers, are also used to a great extent. These, as well as the bushings, should be riveted over inside and outside and great care should be taken in their application to insure tight fit. Applying the bushings or solid plugs to crown bolt holes is not practical, owing to the radius of the sheet.

Welding of staybolt holes has its advantages and disadvantages. This system is no doubt the easiest for the boiler maker, as it is only necessary for him to countersink the holes. Tapping a welded hole, especially electrically welded, is very hard on the staybolt taps. Shop conditions should govern the manner of reducing staybolt holes.

Staybolt holes should be drilled 1/8 inch smaller than the required tap size. It is permissible to punch staybolt holes in the outside wrapper sheet. These holes should be punched undersize and reamed to ⅛ inch smaller than the required size for tapping. By reaming the holes, this will give the holes in the outside wrapper sheet the same angle as the holes in the firebox sheet.

The question arises as to the proper kind of taps. Practically all tap manufacturers have their own idea as to the size, amount of taper, and number of full threads for the taps of their own make. Also, much has been written as to the relative merits of a straight or fluted tap. On a great many stock taps, both straight and spiral fluted, the maximum reamer diameter is so much smaller than the root diameter of the sizing threads, that the threaded section of the tap must do a certain amount of reaming, and, as a result, the cuts are very fine, and, being very light, do not clear themselves, but wad up in the flutes, or gum up between the teeth. The heat generated when this occurs is sufficient to draw the temper of the teeth causing the tap to tear instead of cut.

The most nearly perfect tap will have a maximum reamer diameter of not more than 0.025 inch below the root diameter of the sizing threads; the root of the sizing threads to have the same taper as the reaming portion of the tap.

In re-tapping a hole $\frac{1}{16}$ inch larger, the teeth, on the first few revolutions of the taper section, have the same form as the old thread, and have a tendency to act as a lead screw, so that the new thread will follow the old. The remainder of the taper section will cut out part of the old thread, and form a means of steadying the tap in the hole before the new root diameter is reached, and prevent oversize reaming.

When staybolts are being applied at the same place where threaded it is better to fit the staybolts to the sheet, rather than to a gage. About one in fifty staybolts threaded should be fitted by the threading machine operator. This will eliminate the possibility of staybolts becoming too tight, due to tap wear.

The question of lubricant used for staybolt tapping and threading rests entirely with the boiler shop foreman. A lubricant should be selected that will give the longest tapping service, cut the cleanest threads and that will not harden if allowed to stand for some time before the bolts are applied. With certain makes of lubricant, the cuttings will harden on the foundation ring, if allowed to stand for any length of time.

The question arises, "When tapping for crown bolts, should a tap be used with continuous threads the full length of the water space, or a short tap with long leads?" If the crown bolts are threaded on a turret lathe, threading both ends at the same time, it is better to use a continuous thread tap. If each end of the bolt is threaded separately, it will make no difference if the short tap is used, as the threads on one end may not line up in respect to those on the other.

When applying staybolts, application should start at the foundation ring and work up. This will insure the long bolts being used where they belong. Staybolts should be run in with a motor one size larger than that used for tapping, and this will insure the proper fit. It should not be necessary to use more than a 12-inch wrench when setting bolts. A bolt that is too tight in the sheet is just as bad as a loose bolt.

Hollow staybolts can be applied from the outside, but solid bolts must be applied from the firebox side. Where an entire installation of hollow bolts is applied, the difference in the cost between the hollow and the solid is somewhat reduced, as it is not necessary to drill telltale holes in the hollow bolts; also, application from the outside is faster than from the inside.

The question has been asked, "When using reduced body bolts, should the telltale hole extend into the reduced part of bolt?" Reduced body bolts are more susceptible to breakage in the body than on the threaded portion of the bolt.

Discussions have arisen as to the advisability of burning off staybolts for riveting with the acetylene torch. It is the opinion of some that staybolts cut on the firebox sheet with acetylene have a tendency to become brittle in a short time, allowing the firebox sheets to pull away from the bolts and causing the sheets to corrugate. Where solid bolts are applied, they must be cut off on the firebox side. Acetylene cutting being the quickest and cheapest method, its use for this purpose is general today.

Riveting of staybolts is best accomplished by using a long-stroke, special staybolt hammer, and holding on the bolt with a large dolly bar. Double gunning of staybolts is being practised on some roads. Where a boiler is removed from the frame for repairs, the bolts can be held on with an air jack, providing it is possible to turn the boiler. This should be decided by the boiler shop foreman, and the system used which gives the most satisfaction. Flexible staybolts should be held on with a special air jack, which can be made in any shop. This has proven the most satisfactory plan yet devised as the air jack protects the sleeve threads. The jack is easy to handle, and the air cushion holds the bolt at the same tension all the time.

(d) The waterlegs should be cleaned after blowing down the boiler by washing same out with a hose. The water pressure should be at least 75 pounds. When the mud and scale cannot be loosened with the hose, same should be loosened with chisels of various shapes required to reach all parts of the waterlegs. The hammers or chisels used may be hand or mechanically operated. When such tools are actuated by air, steam or water, they shall be operated at the lowest pressure sufficient to do the work; mechanical hammers and chisels shall not be operated for more than a few seconds at a time at any one spot.

(e) Copper ferrules are used where the effects of expansion and contraction are very severe upon the tube ends where same pass through the tube sheets, usually at the firebox end.

Copper, as it is well known, has a higher range of ductility than any other metal used in mechanical lines and in tenacity is exceeded only by the better grades of iron. In sheet form it gives a more equal distribution of expansion and contraction stresses than any other metal, and for this reason the copper ferrule is ideal for securing a tight joint where the tube passes through the tube sheet.

(f) When the tube hole is out of round or for any reason which will not permit the tube to be rolled to a tight joint, such as, grooving or scoring, the tube hole should be machined out, or welded up and machined out.

(g) After removing the tubes, the flue sheet should be cleaned of all previous welds, any grooving, scorings or holes in the metal about the tube hole, which will not permit the tube to be rolled to a tight joint should be machined out, or welded up and machined out.

Welding-Cutting.—A leaflet by the Craftweld Equipment Corporation, 250 West Fifty-fourth Street, New York, service bulletin No. 235, gives welding and cutting data and operating suggestions of value to the user of welding and cutting equipment.

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15 Park Row, New York

Manager—James D. Andrew.
Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President—Murrel J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

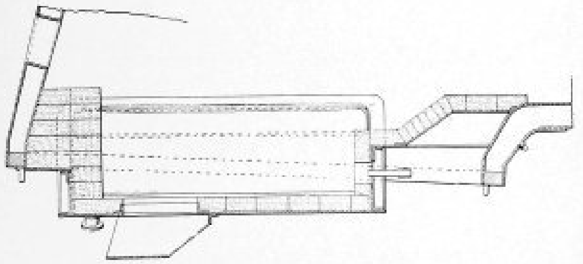
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent Attorney, 1372-1376 National Press Building, Washington, D. C. Readers wishing copies of patents or any further information regarding any patent described, should correspond directly with Mr. Galt.

1,885,932. SELF SUPPORTING WATER BOTTOM. JESSE C. MARTIN, JR., OF LOS ANGELES, CALIFORNIA.

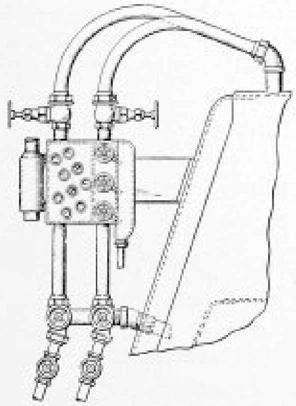
Claim.—A self-supporting water bottom comprising, in combination, a relatively heavy carrier sheet forming one wall of a water enclosing space having an air opening adjacent its central portion, a second rela-



tively light sheet spaced from the first named sheet forming a second wall of the water enclosing space, the end margins of said second sheet and portions thereof adjacent the longitudinal edges of said opening turned into contact with and joined to said carrier sheet to complete a water containing enclosure. Four claims.

1,880,847. WATER GAUGE. JOHN J. DALY, OF VIRGINVILLE, PENNSYLVANIA.

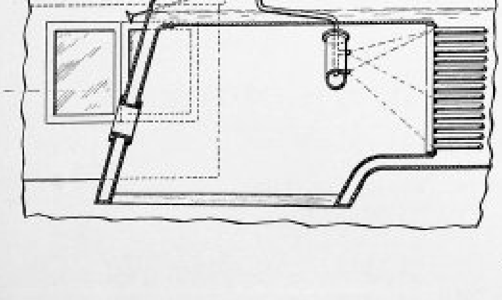
Claim.—In a water gauge for boilers, a housing, said housing including a pair of compartments each independent of the other, water level determin-



ing means for each compartment, and a pair of pipes for each compartment, each pair of said pipes communicate respectively with the upper and lower ends of said compartments. Two claims.

1,887,765. FLUE CLEANER. JOHN H. KOHLER AND AUGUST SCHNEIDER, OF PITTSBURGH, PENNSYLVANIA.

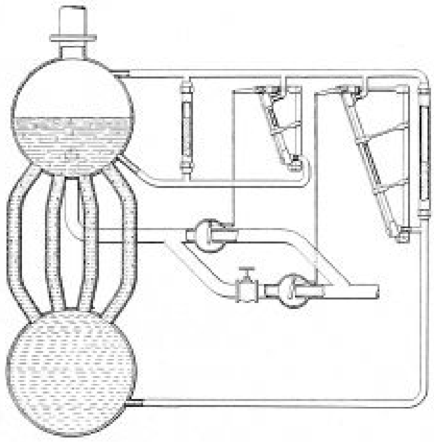
Claim.—The combination with a locomotive boiler provided with a fire-box having a flue sheet at one end and a back-wall at the other end thereof, of a flue cleaner comprising steam-containing means disposed in said fire-box and connected with the live steam space of said boiler,



said steam-containing means having nozzles disposed closer to said flue sheet than to said back-wall at a sufficient distance from said flue sheet and so directed that live steam issuing therefrom will impact against substantially all the flue sheet, and a waterjacket disposed within said fire-box and surrounding said steam-containing means, for the purposes set forth.

1,887,147. REGULATING SYSTEM FOR HIGH CAPACITY BOILERS. WILLIAM L. DE BAUFRE, OF ORANGE, NEW JERSEY, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim.—The method of controlling the water level in a boiler by regulating the water supply thereto which comprises supplying part of the



feed water in accordance with the weight of water in the boiler irrespective of the water level therein, through the medium of feed water supply control means responsive to the head of solid water equivalent to the mixture in the boiler, and part in accordance with control means responsive to the level of the water in the boiler. Fifteen claims.

Boiler Maker and Plate Fabricator

Master Boiler Makers' 1935 Business Meeting

This issue of Boiler Maker and Plate Fabricator is devoted exclusively to a presentation of the "Official Proceedings" of the 1935 Business Meeting of the Master Boiler Makers' Association. It has been a privilege for the staff of this publication to work with the officers and to make this contribution to the welfare of the association. Further, the opportunity has been welcomed to make available throughout the entire railway field the results of this outstanding meeting in the history of the Master Boiler Makers' Association. In point of interest and accomplishment no meeting of this organization has been more successful. Widely supported by superintendents of motive power and mechanical officers, attendance exceeded all expectations. In the space of four hard-working sessions, a broad cross-section of boiler maintenance problems facing the railway mechanical department for solution was covered by reports and by earnest discussion. A vast wealth of practical information, indicating solutions to many of these problems was developed. After studying the work of the association as exemplified by its proceedings in this issue, no question as to its value in the railway mechanical scheme should remain in the mind of any official. This meeting was made possible primarily through the courage and initiative of the secretary, who envisioned a future for the association that would be productive in expanding the knowledge of proper and economical locomotive boiler practice. Its constructive work will be greatly expedited if recognition is accorded the association officially by the Association of American Railroads, as individual mechanical officers already have done. In return for the support given the association this year, the members who were enabled to attend the meeting are better equipped to carry on their work. The practical information on locomotive boiler construction, inspection, maintenance and repair thus developed will influence shop practice on every railroad in the United States and Canada. Through the medium of the proceedings, every mechanical officer, superintendent of motive power, supervisor and boiler department foreman will be advised of new possibilities in boiler work. Members of the association who were unable to attend will gain great benefit from studying the reports and discussion. All these will receive copies of this proceedings issue of Boiler Maker and Plate Fabricator whether they previously have subscribed to the publication or not. Not only will the proceedings be of assistance to the supervisors but it will constitute a real source of education to the boiler staff at large since this issue will reach hundreds of subscribers among the men who in the future will advance to supervisory positions. The boiler making supply trade, many representatives of which were in attendance at the meeting, will reap considerable benefit from the work of the association; for the discussion included the application to modern locomotive boiler practice of materials, tools and equipment which they produce. The Master Boiler Makers' Association merits the co-operation of all these groups. It has a useful work to perform, and the best evidence of its value in the future is demonstrated by the results accomplished at this 1935 Business Meeting

K. E. Fogerty, retiring president

O. H. Kurlfinke, president

F. T. Litz, first vice-president

MASTER BOILER MAKERS' ASSOCIATION

The 1935 business meeting of the Master Boiler Makers' Association convened at the Hotel Sherman, Chicago, Wednesday, September 18, at 10:00 a.m., with Kearn E. Fogerty, president of the association, in the chair. Nearly 150 members, associate members, guests, supply company representatives and their ladies registered at the meeting.

The first order of business was an address by the president which follows:

President's Address

After five long years, and for most of us trying ones, it is my great privilege to address a representative gathering of members of our association. Not as large a group as at conventions before the curtailment of our activities became necessary, because of economic conditions, but one that gives assurance that our association is still active, able and ready to advance to new attainments in service to our railroads.

It has been a long, hard struggle to keep the spirit of the association strong, but it has been accomplished through the efforts of your officers and particularly of your secretary. In 1931, while it was impossible to hold the convention planned for that year, nevertheless the association published the complete proceedings which had been prepared for the meeting. Again in 1933, through the co-operation of The Boiler Maker, published by the Simmons-Boardman Publishing Company, it was possible for us to present valuable information covering boiler practice to our membership and to our mechanical officers in the form of a "Convention in Print."

For a time last Fall it appeared that an actual convention might be held in the Spring of 1935 on the basis of meetings co-ordinated with those of other of the minor mechanical associations. Official action of the Association of American Railroads prevented these plans from materializing, but such meetings as we are now holding were substituted. Many handicaps have arisen in connection with plans for the present meeting but with the whole-hearted co-operation of mechanical officials of the railroads in general, this gathering has been made possible.

A business meeting confined solely to officers of the association had but little appeal, since it could accomplish no more than similar meetings in the past few years. Our object is not to perpetuate an organization which does not serve—simply for personal gratification of the officers. This association has always existed for the constructive work that it could accomplish. In the thirty-five years which constitute its history, it has contributed a vast fund of practical knowledge on boiler construction, maintenance, repair and inspection that has been invaluable to the railroads of the United States. The greatest possible endorsement of this purpose is evidenced by the fact that superintendents of motive power have authorized members of their staffs to attend—not a convention, but an amplified business meeting of this association.

To the end that their faith in us would not be mis-

I. H. Pool, second vice-president

L. E. Hart, third vice-president

W. N. Moore, fourth vice-president

1935 BUSINESS MEETING

placed—this business meeting has been made a medium through which we hope to contribute to the solution of at least some of the troublesome and costly locomotive boiler maintenance problems, which are now facing the mechanical department.

This opportunity to demonstrate the value and sincerity of our efforts must be fully realized. Upon the results accomplished will largely depend our future. If, at this business meeting, information is developed from the practical standpoint that will assist mechanical officers in any degree in the solution of boiler problems and in the process save maintenance expense, then our efforts to receive the recognition and support of the Association of American Railroads will be fruitful. It is above all our ambition and our goal to receive such recognition, as an association capable of contributing essential data on matters pertaining to the locomotive boiler. Approval of this body would give official standing to our work and assure a future which could be devoted to service, with the uncertainty of the past few years eliminated. Actually, we aspire to the position of becoming a section of the Mechanical Division of the Association of American Railroads on the same status as comparable associations which have been recognized by that organization.

Our success in this endeavor largely rests on the productiveness of this business meeting.

In the short time available, it was impossible to prepare as complete a program of topics for discussion as the long lapse of time since our last meeting would warrant. The topics presented should be only suggestive of other important matters to be brought before the meeting. All the discussion possible on them will be developed but we must go much further in surveying the entire field of locomotive boiler work and, in the process, bring out as much information on as many subjects of concern to our railroads as our two days of meeting together will permit.

If we do this, the value of our work will be recognized and the future of the association will be assured through the support of our mechanical officials.

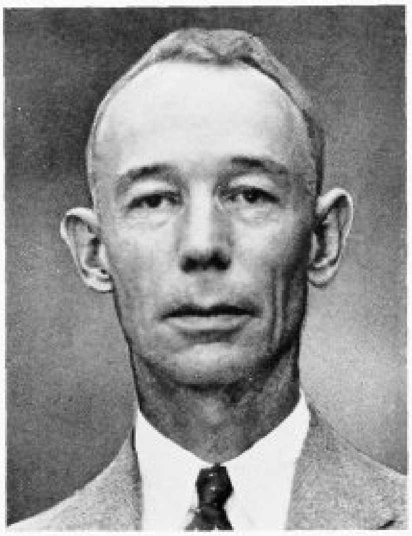
Perhaps the most vital function which this association performs at its meetings is that of broadening the viewpoint of its members. At no time in the history of the railroads has education of its supervisors in matters pertaining to their several crafts been of greater importance than now. This applies particularly to the younger members whose responsibilities in the shop are increasing tremendously with the greater demands for production now being experienced.

Curtailment of business brought disastrous changes in shop organizations. Personnel has suffered on every railroad. The supervisory staffs, including foremen in the boiler department, have been drastically reduced. Now that the rebuilding process has commenced, great gaps exist in the ranks of those qualified by training and experience to conduct shop operations. Many of our older members have retired in the course of the past five years.

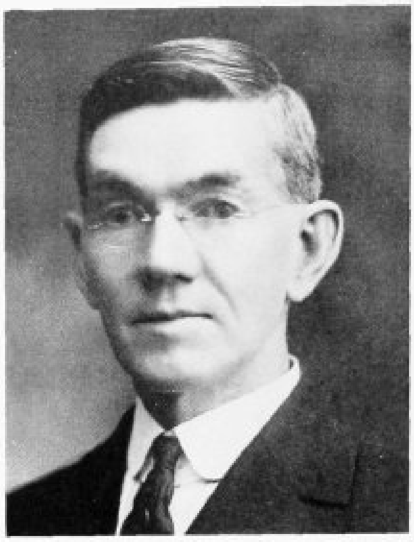
One of the greatest problems of all now facing the railroads is that of rehabilitating their skilled personnel and recovering the morale on which successful operation in the future depends.

This association has proved its value in accomplishing the advancement of its younger members. Those of us who have lived our lives in the boiler shop can contribute a great wealth of knowledge to those who follow us, if we are permitted to meet with them. It cannot be possible that our officials will fail to recognize the advantages to them of this medium of educating the men who are advancing to supervisory positions.

All the drastic measures necessary for existence in a depression will be forgotten once business reaches even a semblance of normal. If such associations as that of the Master Boiler Makers' have been allowed to lapse because of economic conditions, it will then be too late



C. A. Harper, fifth vice-president



W. H. Laughridge, treasurer

A. F. Stiglmeier, secretary

to recognize their worth and to rehabilitate them. We have bravely struggled to keep this organization intact through five years of depression in order that we might again function when recovery took place. It is the sincere hope of the officers of the association that this effort will not have been in vain.

Annual Report of the Secretary

Albert F. Stiglmeier, secretary of the association, next presented his annual report as follows:

Receipts from April 16, 1931 to July 31, 1935

May 11, 1931—Dues	$55.00	
Proceedings	3.00	
		$58.00
October 24, 1931—Advertising	$1,360.00	
Dues	45.00	
Proceedings	12.00	
		1,417.00
November 25, 1931—Advertising	$225.00	
Dues	5.00	
Proceedings	3.00	
		233.00
December 21, 1931—Advertising		95.00
February 15, 1932—Advertising	$65.00	
Dues	5.00	
		70.00
April 30, 1932—Dues		20.00
July 2, 1932—Dues		25.00
October 31, 1933—Advertising		65.00
July 31, 1935—Dues		10.00
		$1,993.00
Total cash balance as of April 15, 1931		844.61
Interest as of November 8, 1933		51.25
Check on debit as of April 30, 1932		20.00
Total cash balance April 15, 1931, with receipts		$2,908.86

Receipts were as follows:	
Cash balance as of April 15, 1931	$844.61
Interest as of November 8, 1933	51.25
Check of April 30, 1932, on debit	20.00
Advertising	1,810.00
Proceedings	18.00
Dues	165.00
Total	$2,908.86

This report was accepted and entered into the minutes of the meeting.

Treasurer's Report

William H. Laughridge, treasurer of the association, presented his annual report, covering the period April 15, 1931, to July 1, 1935. Through the entire depression period, the affairs of the association have been handled at a very minimum of expense as the report indicates. The report appears in the next column.

Receipts

Balance brought forward	$844.61	
Received from secretary May 17, 1931, to July 31	1,993.00	
Total receipts		$2,837.61
Interest on money in bank	$51.25	
Check on debit, for signature	20.00	
		71.25
Total		$2,908.86

Disbursements

Summary—April 16, 1931, to December 31, 1931:		
Proceedings cost with percentage	$1,590.80	
Percentage 25 percent on dues collected	83.50	
Auditing books	5.00	
Premium on bonds	15.00	
Incidentals secretary's office	41.72	
Stenographic service	60.00	
Stationery	43.75	
		$1,768.77
January 1, 1932, to December 31, 1932:		
Percentage 25 percent on dues collected	$12.50	
Premium on bonds	22.50	
Incidentals secretary's office	53.52	
Stationery	27.50	
Percentage 50 percent on advertising	32.50	
Debit checks	25.00	
File cabinet secretary's office	50.00	
		223.52
January 1, 1933, to December 31, 1933:		
Premium on bonds	$22.50	
Incidentals secretary's office	25.46	
Checks refunded	10.00	
Percentage and advertising money advanced	65.00	
Stationery	81.20	
		204.16
January 1, 1934, to December 31, 1934:		
Premium on bonds	$15.00	
Incidentals secretary's office	59.72	
Stationery	80.25	
Meeting Chicago September 17 and 18	31.90	
		186.87
January 1, 1935, to July 31, 1935:		
Stationery	$93.32	
Incidentals secretary's office	25.32	
Tax on checks	.56	
		119.20
Total disbursements		$2,502.52
Total Receipts		$2,908.86
Total Disbursements		2,502.52
Balance in treasury		$406.34

Following the reading of the reports of the secretary and the treasurer a short address was given by L. S. Blodgett, managing editor of Boiler Maker and Plate Fabricator in which attention of the members was called to the importance of the work to be done at this business meeting and the part the association can play in the future in railroad activities.

Next John M. Hall, newly appointed chief inspector of the Bureau of Locomotive Inspection of the Interstate Commerce Commission, United States Department of Commerce, addressed the association. His presentation appears on page 267.

Honorary Membership

Secretary Stiglmeier in presenting the names of members to be considered for honorary membership, stated: "Gentlemen, I believe we are in order when we give to this meeting the names of those eligible for honorary membership, who, because of old age, ill health, or other sufficient cause have been obliged to retire from active service, according to Article XL, Section 3, of our Constitution and By Laws." He then proceeded with the reading of names which were proposed for honorary membership and which were referred to the executive board for approval.

Subsequently at the Thursday afternoon session, the Executive Board report on honorary members was presented by Mr. Stiglmeier. The following were recommended to be made honorary members and were confirmed by vote of the association:

A. F. Batchman, (formerly) boiler foreman, New York Central System.

P. S. Hursch, (formerly) district boiler inspector, Buffalo, Rochester & Pittsburgh R. R.

W. H. Laughridge, (formerly) general boiler inspector, Hocking Valley R. R.

A. Mihleisen, (formerly) general boiler foreman, A. T. & S. F. Ry.

E. E. Rapp, (formerly) boiler foreman, Nickel Plate R. R.

R. Russell, (formerly) boiler inspector, Grand Trunk R. R.

J. E. Stokes, (formerly) boiler foreman, Illinois Central R. R.

J. T. Walsh, (formerly) general boiler foreman, St. Louis & San Francisco R. R.

R. M. Williams, (formerly) locomotive inspector, Interstate Commerce Commission.

C. F. Young, (formerly) general boiler inspector, New York Central System.

G. G. Nicol, (formerly) assistant general boiler inspector, A. T. & S. F. Ry.

J. L. Welk, (formerly) general boiler inspector, Wabash R. R.

T. P. Madden, (formerly) chief boiler inspector, Missouri Pacific R. R.

The Executive Board also recommended that further consideration be given the following for Honorary Membership:

C. M. Browning, (formerly) general boiler foreman, Grand Trunk R. R.

J. B. Bruce, (formerly) boiler foreman, St. Louis & San Francisco R. R.

J. E. Cooke, (formerly) master boiler maker, Bessemere & Lake Erie.

R. P. Crimmins, (formerly) district boiler inspector, C. C. C. & St. L. R. R.

T. J. McKerihan, (formerly) general boiler inspector, Pennsylvania R. R.

J. J. Mansfield, (formerly) chief boiler inspector, Central R. R. of New Jersey.

Emil F. Zeigenbein, (formerly) boiler foreman, Michigan Central R. R.

A. C. Dittrich, (formerly) general machinery inspector, Soo Line.

Secretary Stiglmeier next addressed the meeting as follows:

I am going to try and give to you the details of what has transpired in the last year. It is very gratifying to me to see this large gathering here today. Many of you here are deserving of much credit for the sacrifices you are making, same being best known by myself.

Since our meeting on September 18, 1934, at Chicago, with the Committee on Coordination of Conventions as appointed by the A.R.A. in the year 1932, we have met with many obstacles. At the meeting in question we anticipated holding a convention in May, 1935. In February, 1935, we were informed of the organization of the Association of American Railroads. It was understood by the Committee on Coordination of Conventions that this would in no way interfere with the holding of our 1935 convention. On February 6, 1935, we received a letter from V. R. Hawthorne, secretary of the Association of American Railroads, in which he asked for the names of the officers of our association. This list was forwarded on February 8. Not being familiar with the workings of the Association of American Railroads, I asked Mr. Hawthorne for any information he might have regarding the status of a 1935 convention.

On March 18, we received a letter from T. Duff Smith, secretary of the Committee on Coordination of Conventions, with the information that they had a letter from J. R. Downes, vice-president of the Association of American Railroads, which stated that, due to their association not having absorbed the smaller associations, they did not deem the holding of conventions necessary. Mr. Smith further wrote that while conventions would not be held, they would request that business meetings be authorized.

Under date of March 25, I made a personal request to E. R. Hall, chairman of Division V, Mechanical, Association of American Railroads by letter, asking him to intercede for recognition for our association. In a letter on April 10, he assured me that he would gladly do this at the next meeting of his committee.

On April 16, T. Duff Smith wrote that they had heard from the Association of American Railroads, and arrangements should be made for a two-day meeting September 18 and 19, 1935. Not being satisfied with the information given by Mr. Smith, I wrote to him asking for the true status of these meetings. On May 1, I received a reply, which read as follows: "Yours of the 19th. You would note from Mr. Downes replies, that

Officers of the Master Boiler Makers' Association—1935-1936

President: O. H. Kurlfinke, boiler engineer, Southern Pacific Company, 65 Market Street, San Francisco, Cal.

First Vice-President: Franklin T. Litz, foreman boiler maker, C. M. St. P. & P. R. R., 2265 Roosevelt Street, Dubuque, Ia.

Second Vice-President: Ira J. Pool, district boiler inspector, Baltimore & Ohio R. R., 5610 Merville Avenue, Baltimore, Md.

Third Vice-President: L. E. Hart, foreman boiler maker, Atlantic Coast Line, 621 Hammond Street, Rocky Mount, N. C.

Fourth Vice-President: William N. Moore, general boiler foreman, Pere Marquette R. R., 625 College Avenue, S. E., Grand Rapids, Mich.

Fifth Vice-President: Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis (Big Four), 814 Big Four Building, Indianapolis, Ind.

Secretary: Albert F. Stiglmeier, general foreman boiler maker, N. Y. C. System, 29 Parkwood Street, Albany, N. Y.

Treasurer: William H. Laughridge, retired general boiler inspector, Hocking Valley R. R., 537 Linwood Avenue, Columbus, O.

Executive Board

J. L. Callahan, chairman. John Harthill, secretary.

One Year

John Harthill, general foreman boiler maker, Collinwood Shops, N. Y. C. System, 14708 Coit Road, Cleveland, O.

M. A. Foss, service engineer, Locomotive Firebox Company, 310 S. Michigan Avenue, Chicago, Ill.

E. C. Umlauf, general boiler inspector, Erie R. R., 269 Erie Avenue, Susquehanna, Pa.

Two Years

George L. Young, foreman boiler maker, Reading Shops, Reading Company, 922 Madison Avenue, Reading, Pa.

C. W. Buffington, general master boiler maker, Chesapeake & Ohio R. R., 50 Marue Drive, Huntington, W. Va.

A. W. Novak, general boiler inspector, C. M. & St. P. R. R., 4449 Xerxes Avenue, Minneapolis, Minn.

Three Years

J. L. Callahan, general boiler inspector, Chicago Great Western R. R., Oelwein, Ia.

M. V. Milton, chief boiler inspector, Canadian National Ry., 1548 Duffern Street, Toronto, Ont.

Charles J. Klein, district inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission, 330 New Scotland Avenue, Albany, N. Y.

he does not state anything about our request, or advise about business meetings, but reiterates his statement about conventions. To be sure of our ground before going further with the arrangements for business meetings in September, Mr. Roesch, chairman of the A.R.A. Committee on Coordination of Conventions had an interview with Mr. John Purcell, chairman of the A.R.A. Committee on Conventions, with the result that Mr. Purcell says to go ahead with our meetings with the same condition as last year. There is to be no expense to the A.R.A. This means that those attending must either arrange with their individual company as to paying their expenses, or come at their own expense."

On the strength of these letters, I forwarded to ninety-seven general superintendents, and superintendents of motive power, letters asking for their support and cooperation to make our meeting a success, by having as many as possible in attendance. The responses that I received were most gratifying. I received sixty-seven replies, and many of them made mention of the work done by our association as being of great benefit to the railroads.

Regardless of the many favorable responses we had received, we were meeting many obstacles. It seemed as though someone was trying to get our railroad officials who were very favorable to the holding of our meeting to change their minds. This condition not only existed on our railroad but on many of the others, the contention being, "Due to not being affiliated with the Association of American Railroads they did not deem it necessary for us to hold our meeting."

After much correspondence and visits with railroad officials, I still continued to work to create harmony with the Association of American Railroads, for I was of the opinion that there was a vast misunderstanding. On September 5, I had the pleasure of meeting with J. R. Downes at his Washington, D. C., office. My visit with Mr. Downes was a very pleasant one. I conveyed the idea to him that the Master Boiler Maker's Association officers at no time anticipated working contrary to the wishes of the officers of the Association of American Railroads or the officers of our railroads. Due to the fact that our members in the past have been true and faithful to the railroads, and the work of our association having been of much benefit to them, we were of the opinion that favorable action should be taken by the Association of American Railroads, so that we might continue with our work, as we were willing to serve them as in the past. I further stated that we were very grateful for the change of attitude that was being shown of late, wherein mention was only made, that due to financial conditions it would be impossible to meet personal expenses of many that would be in attendance. Also Mr. Downes remarked that if the railroads cared to have their men attend and could meet their personal expense it would be their individual matter.

I have tried to give to you the status of this meeting during the past year. I have worked hard for you, been fair to all at all times, and worked many hours meeting your friends, and the Simmons-Boardman Publishing Company, publisher of BOILER MAKER AND PLATE FABRICATOR, who have printed gratis your meeting program, and will also publish your meeting in proceedings form, also gratis. One thousand copies of these proceedings will go forward in October, 1935, to our members and to all railroad officials of importance in the mechanical associations.

At this time I am going to make an appeal to you to remember that your meeting is on trial. Many no doubt have instructions to report on your return any actions taken at this meeting. There is one thing you gentlemen can do, and that is, when topic reports have been read, to discuss them thoroughly and put something into the proceedings that will be of benefit to the members and their railroads. If this is done, I assure you that our friends among the railroad officials will continue to fight for your association as they have in the past. Much credit belongs to them, they having made it possible for your presence here today, after much opposition.

On my trip to Washington I also had the pleasure of meeting with John M. Hall. My visit with him was a most pleasant one and very encouraging, he having assured me that he would arrange for at least ten of his inspectors to be in attendance at the meetings, and would at all times support our association for the good work they had done in the past. He has told you the same here today, and I want to tell you gentlemen that when you have a friend like Mr. Hall who will bring ten of his inspectors to your meeting in this time of depression, you have a true friend. The only thing you can do for Mr. Hall is to give him the same support and cooperation as he is giving to you at this meeting, there being an old saying, "you only get what you give."

Secretary Stiglmeier read the names of members who have died since the last meeting.

MEMORIALS

J. A. Anderson, (formerly), Superintendent Boiler Department, Industrial Brownhoist Corporation.

W. G. Bell, General Boiler Inspector, Florida East Coast Railway.

A. E. Brown, (formerly), General Boiler Foreman, Louisville & Nashville R. R.

R. W. Clark, (formerly), General Boiler Foreman, New York, Chicago & St. Louis R. R.

P. G. Conrath, Past President (formerly), Tube Expert, National Tube Company.

D. J. Champion, (formerly), President, Champion Rivet Company, Cleveland.

G. G. Fisher, Member Executive Board, (formerly), General Boiler Foreman, Belt R. R.

Frank Gray, Past President, (formerly), Tank Foreman, Chicago & Eastern R. R.

Dr. C. H. Koyl, (formerly), Water Engineer, Chicago Milwaukee & St. Paul R. R.

D. A. Lucas, Past President, (formerly), Vice-President, Prime Manufacturing Company.

J. A. McCarthy, (formerly), Boiler Foreman, Elgin, Joliet & Eastern R. R.

Roy McKinney, (formerly), Boiler Foreman, C. & E. J. R. R.

Martin Murphy, (formerly), General Boiler Inspector, Baltimore & Ohio R. R.

M. O'Connor, retired, (formerly), Boiler Foreman, Chicago & North Western R. R.

J. R. Reese, (formerly), Boiler Foreman, Chicago Milwaukee & St. Paul R. R.

E. H. Ritter, (formerly), District Boiler Inspector, Baltimore & Ohio R. R.

D. A. Rogers, retired, (formerly), General Boiler Foreman, American Locomotive Company.

E. W. Rogers, retired, (formerly), General Boiler Foreman, American Locomotive Company.

W. B. Shoemaker, (formerly), Superintendent of the Hibben Company.

C. H. Usherwood, (formerly), Boiler Foreman, New York Central System.

George Wagstaff, Past President, (formerly), Engineer, American Arch Company.

A committee consisting of William N. Moore, A. W. Novak, and H. A. Bell, was appointed to present memorials for deceased members. This committee presented the following memorials at the Thursday afternoon session:

Whereas, the Maker of the Universe, in His infinite wisdom, has called to the Eternal Home our esteemed and beloved brothers of the Master Boiler Makers' Association, therefore it is befitting that we assembled today pause to do honor to our departed brothers.

It is with profound regret that we part with you. We have enjoyed close comradeship with you. We will miss you more than we can tell. Your untiring efforts for the betterment of your fellow men and mankind have endeared you to us and left a sweet memory of respect, loyalty and love in our hearts that will remain so long as life shall last.

To the ones left at home, the fireside, your families, we, this association, assembled this day, and its members, convey to you our heartfelt sympathy and hope you will have that peaceful consolation that your loved ones have lived a full, productive life and therefore have gone to their reward where there is no pain or sorrow.

WEDNESDAY AFTERNOON SESSION

The Wednesday afternoon session was devoted to the reading of Topic No. 1, "Boiler and Tender Tank Corrosion and Pitting—In Service and In Storage," prepared by a committee consisting of J. L. Callahan, general boiler inspector of the Chicago Great Western Railroad Company, chairman; E. J. Reardon, service engineer, Locomotive Firebox Company, and A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific Railroad Company. This report and the discussion appear on page 270.

THURSDAY MORNING SESSION (SEPTEMBER 19)

On the second day the session was convened by the president, Kearn E. Fogerty, at 9:30 a.m. An address was presented by the secretary, Albert F. Stiglmeier, covering the activities of the association since it last met in convention in 1930. The address appears below:

Secretary Stiglmeier's Annual Address

For several months past I have worked untiringly in the preparation of an outstanding program for this two-day meeting of the association. Those of you who are in attendance are to be congratulated, knowing the sacrifices many of you have made to be present. This meeting is being held in spite of considerable opposition from certain official circles.

When it is fully realized by the officers of the Association of American Railroads that this hard-working group of practical master boiler makers is making a courageous attempt to save a valuable organization from extinction in order that, in the future, it may function to the everlasting benefit of our railroads, as it has in the past, it cannot be conceived that less than complete official approval will be given the effort.

For thirty-five years, we, the Master Boiler Makers' Association existed as an independent organization, and, in the course of that time, produced information on practical phases of locomotive construction, inspection, maintenance and repair that placed us in the front rank of the lesser mechanical associations serving the railroads. The only justification for the existence of our association has been and still is the ability of our membership to add to the fund of knowledge concerning locomotive boiler and tender practices. That this has been recognized is evidenced by the wholehearted support given by mechanical officials throughout the country, whose authorization has been essential to your attendance at this meeting, in many cases after much opposition. The support thus evidenced is extremely gratifying.

For the past five years economic conditions have not permitted our association to meet in convention. In spite of this curtailment of our activities, we have used every available means to keep our membership interested in our association work, so that no lapse might occur when our regular convention or meetings again could be resumed. In 1931 proceedings were published, containing addresses of high railroad officials, as well as committee reports and special papers that had been prepared for a convention which was never held. In the October, 1933, issue of THE BOILER MAKER a complete "Convention in Print" covering important developments in the art of boiler making, was presented to the railroad industry through the medium of this publication, which was made possible by the Simmons-Boardman Publishing Company, publishers of THE BOILER MAKER. The information thus made available by our association was distributed throughout the membership and among railway mechanical officials generally.

Early in 1935, when a two-day annual business meeting was proposed for September 18 and 19, 1935, with every evidence of the approval of the Association of American Railroads, it was recognized as an opportunity to bring all the officers, committee members, and as many association members as possible together again. More than this, however, it has been our first chance in five years to collect and discuss valuable information on boiler maintenance problems, which will repay the railroads many times over for the support, evidenced by superintendents of motive power in allowing their representatives to be in attendance.

We believe that a business meeting amplified to include officers, committee members and as many of our members as possible, will be able in a two-day session to solve many of the troublesome problems that have arisen in recent years since our last convention.

While our association is in no way affiliated with the Association of American Railroads, the lack of interest, and, in fact, direct opposition from certain official quarters, has militated against our attempt to keep our association together. This policy of antagonism should be altered and the courage and vitality of our association to function under difficulties should be encouraged officially. The future success of the railroads will depend largely upon the same qualities in their personnel, which are now being expressed by our association members.

One of the important features of conventions; namely, exhibits of material, tools and equipment will, of course, not be made at this meeting. Nevertheless, it is expected that supply company representatives, who in the past have been interested in the work of the Master Boiler Makers' Association, will loyally support the valiant efforts being made by our association again to become an active factor in advancing the technique of locomotive boiler and tender maintenance.

I feel that this occasion should not pass without expressing my gratitude to the officers, committee members and members for their support and co-operation, particularly to the Simmons-Boardman Publishing Company, for the inspiration and assistance that I have received from them.

During the years since 1931 our members have demonstrated that they want to carry on their work, however diverse the views of our members may be upon methods and procedure, however varied their ways One active in our association soon realized that there exists, despite such adversity, a fundamental desire for worthy deeds, and the fulfillment of such purposes in themselves spell success for an Association. Our members will argue their various problems, they will differ about methods, but when they realize the worth of a solution, they unite for the accomplishment. In that spirit of unity I now call upon our members to reinstate delinquent members—to build up our membership. In our effort to hold our membership, let me urge the continuance within our association, of all its activities for the benefit of our railroads. I also want to impress upon you at this time the importance of making your work such that it will attract the attention of your superior officer.

We should seek to attract them, not by aggressive means, but by working for their benefit. Also the young man in particular should receive your attention; he has youth, vitality and energy. We should utilize his enthusiasm for doing things that will benefit him and our railroads. Imbued with noble ideas, trained in right and human ideas and in high thoughts, they will come into that leadership with a fine sense of humanity and genuine recognition of the interdependence of human beings in this struggle for existence, which will make for bigger, better and nobler men, more worthy for leadership than they would have been without the training and confidence and support you have given to them.

During the past years, due to the depression many excellent and worthy members have been compelled to leave us. Their act was not prompted by any loss of interest in our association or its principles, but rather by events beyond their control. We, who have been active, remember well these members; they loved their work, and were ever ready to aid their fellow members. These members helped build our association to its present position and deserve our gratitude and aid. We want these members back with us and I feel it is our duty to bend every effort to try and help place them again in their former positions if at all possible. I am also interested in the members who, despite the long siege of the depression have retained their membership in our association—many at great sacrifice, and have continued to support its activities. In my opinion these men are the backbone of our association. Through their loyal and continued support our association has been able to maintain and successfully to continue its work. The way to reach the true friend of our association is through the heart. The way to reach the human heart is through service, and that service should be extended by every member of the Master Boiler Makers' Association to his railroad.

I am profoundly impressed with the zeal and fine spirit of our committee members at this time. They have worked faithfully to maintain and expand the activities of our association; they have shown unity and loyalty that our association might prosper and continue to serve our railroads. The accomplishments and progress of our association would not be possible without the free and generous support of these committee members, together with the leadership of our officers. Let me, therefore, appeal to you today and urge you to continue this splendid support and co-operation, and to inspire our delinquent members with tireless zeal for the continuance of their membership. Last of all, let me ask our railroad officials and officers of the Association of American Railroads to give official approval for the continuance of the Master Boiler Makers' Association and our annual meeting, for we assure them that more than ever before, we are anxious to help find solutions to the many costly problems in boiler and tender maintenance, which our practical knowledge so well equips this association to develop.

Committee Reports

Following this address, Topic No. 2, "Fusion Welding As Now Applied to Boilers and Tenders" was presented by a committee consisting of Ira J. Pool, district boiler inspector, Baltimore & Ohio Railroad System, chairman; L. C. Ruber, superintendent of the boiler department, The Baldwin Locomotive Works, and H. H. Service, general boiler inspector, Atchison, Topeka & Santa Fe Railway Company. It was moved that the report published in the "Convention in Print" issue of The Boiler Maker, October, 1933, be incorporated with the present report and discussion held on both papers. The reports appear on page 276, followed by the discussion of this subject.

Next in the order of business O. H. Kurlfinke, boiler engineer, Southern Pacific Company, presented a special report on "Safety in the Operation of Locomotive Boilers Increased by Multiple Application of Boiler Drop Plugs." This report and discussion appear on page 281.

Address by Former Chief Inspector A. G. Pack

Alonzo G. Pack, former chief inspector, Bureau of Locomotive Inspection of the Interstate Commerce Commission, addressed the association as follows:

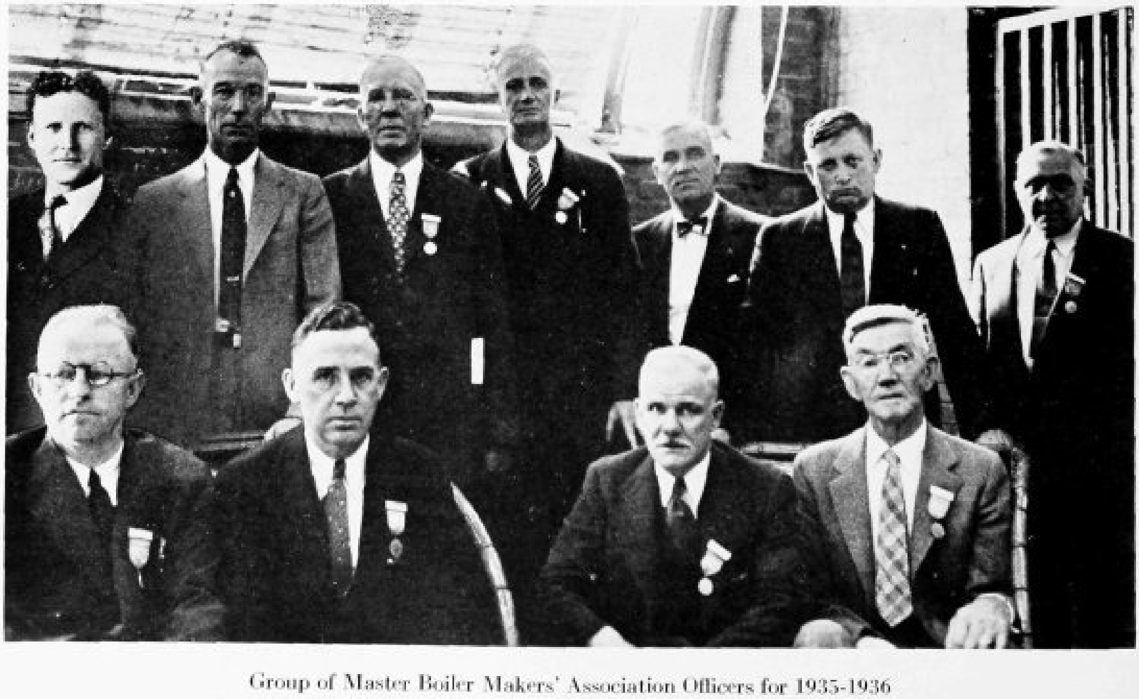
Fifty-three years ago this month I started on the railroad in my first job in the boiler shop of the Chesapeake & Ohio Railroad. I have since been with the government twenty-four years. My life is an open book. You all know what I have done. I have done the best I could for all those with whom I was associated and with whom I had to deal.

I want to say to you that it is mighty gratifying to me to see such excellent attendance at this meeting. It is remarkable under the present circumstances, after the depression that we have gone through for nearly six years.

I have been a member of this organization for something like twenty-one years. I am proud of it. I have done all that I could to advance the success of this organization and of its members with the sole object of reducing locomotive boiler accidents and improving the condition of motive power.

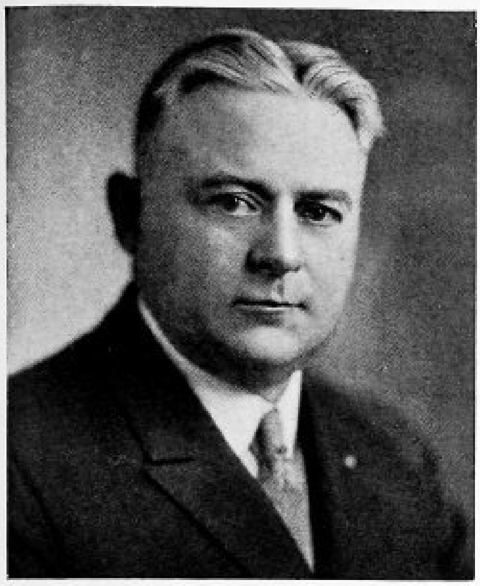
It is a peculiar man who cannot understand the value of the interchange of ideas at these conventions and between our association and others. A man's knowledge is of little value to him or of little value to society if he cannot impart his experiences, the knowledge he has

(Continued on page 269)



Group of Master Boiler Makers' Association Officers for 1935-1936

(Standing, left to right) W. N. Moore, C. A. Harper, E. C. Umlauf, F. T. Litz, J. L. Callahan, A. F. Stiglmeier (secretary), C. J. Klein. (Seated, left to right) O. H. Kurlfinke (president), I. J. Pool, M. V. Milton, W. H. Laughridge (treasurer)



Chief Inspector John M. Hall

Value of Master Boiler Makers' Association in promoting the

SAFETY OF LOCOMOTIVES

By John M. Hall*

Because of our mutuality of interests and because of my long acquaintance with and friendship for members of your association I welcome and appreciate this opportunity to meet with and address you. I rejoice with you that conditions are so improved that you can hold this meeting and trust that there will be no more interruptions of your annual meetings from the cause with which we are all too familiar.

You have been on the job and doing your duty like good soldiers during the years that these meetings have been denied you, but much more could have been accomplished in advancement of the art of boiler making and maintenance had you been able to make personal contacts and listen to the other fellow's viewpoints such as can be done on occasions like this. It does not greatly enlarge a human being's knowledge or ability to keep his nose to the grindstone and play a lone game. Association with our fellows in the same line of work is essential if we are to avail ourselves of the experiences of others.

There is confronting the railroads today a very serious situation. Will they ever have the volume of business they had some few years ago? Shall locomotives and cars, both passenger and freight, be constructed of smaller capacity, relatively lighter in weight than comparable equipment built of conventional materials, with more trains run at higher average speeds? Will other forms of power be substituted for steam? Change is inevitable, perhaps all these things and many others yet undreamed of may come to pass, but because of the economics involved, if not because of engineering problems, such changes must necessarily be brought about through the comparatively slow process of evolution, rather than revolution. The battle between different forms of power is now on, but the steam locomotive has thus far been able to hold up its end at less ultimate cost than the other forms of power and many well informed people predict that it will continue to do so, except possibly for some special forms of service. It would seem therefore that your jobs as master boiler makers are not in present jeopardy and may not be so in the future if you continue to contribute, as you have in the past, to the progress continually being made in the construction, repair, and care of locomotive boilers.

The locomotive boiler is one of the most interesting things we have in the railroad business. Going away back into the early years of history, the ancients had three elements which they assumed made up the world—fire, air, and water. That was when knowledge was starting. They recognized two of the principal things we have in the locomotive boiler—fire and water, the former being non-existent without the presence of air. We all have knowledge of great conflagrations, we know what uncontrolled fire will do. Likewise we all have knowledge of the devastation wrought by floods, we know what uncontrolled water will do. Human effort is of no avail when either of these forces become uncontrolled. But in the boiler we have a device that harnesses both, yet keeps the two apart, keeps each from injuriously affecting the other and induces them to work jointly for mankind. In the boiler we have the co-operation of two natural enemies working for a useful purpose, all brought about by the ingenuity of man for his benefit.

The boiler is the stomach or vitals of the locomotive. Like the human stomach it must have a sufficient capacity and be kept in good repair or else we have a failure. The care of the boiler is as essential as the making of it when new. Without proper care we are sure to meet with disaster. It takes men of experience to give this care, men of strong characters such as you master boiler makers, who can and will call a halt on the use of boilers that may be in condition to endanger life or limb, men who know what repairs should be applied, and how they should be applied. The favorable development of your association is due to your diligent efforts in working together harmoniously in promoting betterment in the art of boiler construction and repair by constant and earnest study of the difficult problems that confront you. In this process you have helped your association, yourselves as individual members, your employers, the men who are under your jurisdiction and other railroad employees, the boiler making industry, and the public, both shippers and travelers.

* Chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission, Washington, D. C.

I appreciate the good work of your association from which I, as an individual, and the Bureau of Locomotive Inspection as a whole, have received as much benefit as any of your members or any of the railroads that you represent. Speaking of the bureau collectively, we have always done everything that we could, not only to advance the interests of your association, but also to advance the interests of each member as well, and you may be assured that we will not forsake the worthy cause.

The Bureau of Locomotive Inspection, through the medium of the Locomotive Inspection Law and Rules, helped by this association and other associations of railroad men, has worked with you to eliminate unsafe practices and practices of doubtful value from our chosen field of endeavor, but we must keep everlastingly at it if we are to take our rightful part in the promotion of safety. Efficiency and economy are blood brothers and inseparable companions of safety, so that in promoting safety we serve a triple purpose.

We find in our endeavor to enforce the Locomotive Inspection Law and Rules that most of the agencies concerned are very good co-operators, therefore we feel that there need be little of the element of compulsion exerted because we have, very generally, voluntary and friendly co-operation. This is the main reason why such good results have been obtained. I am not going to weary you with statistics but I am sure that you will be interested to know that in connection with your part of our work—the boiler—in the fiscal year ended June 30, 1934, the last year for which full information is available, there was a reduction of 92.6 percent in the number of accidents as compared with the fiscal year ended June 30, 1912, the first year the Boiler Inspection Act was operative; a reduction of 94.8 percent in the number of persons killed, and a reduction of 89.9 percent in the number of persons injured. This reduction means that in 1934 there occurred 63 accidents due to failure of some part or appurtenance of locomotive boilers instead of 856 as in 1912, 4 persons killed instead of 91, and 77 persons injured instead of 1005.

We have always taken the position that preventive treatment, prevention of serious defects, is the first requisite in safe and efficient maintenance. To carry out this requisite we need the help of the designer, the constructor, the master boiler maker who has charge of maintenance, and the journeymen. The completed boiler is no better, as a whole, than its weakest component, therefore each person engaged on the work must do his just share, contribute his best knowledge and skill, if we are to have safe and enduring construction and safe use. The successive steps after good design and good construction are thorough inspections that enable the early discovery of all conditions which indicate that defects are in the process of development, and, following such discovery, the application of adequate repairs.

If preventive treatment is carried to its logical conclusion many annoying and unnecessary delays and expensive repairs while the locomotive is rendering its term of service will be avoided. However, the construction and ills of a boiler are such that deterioration, which cannot be entirely controlled by care and light repairs, eventually brings on the necessity for major repairs, and it is at this point where preventive treatment, in the form of thorough repairs to all parts that may develop weaknesses during the next term of service, must start all over again.

It is well known by this time that so-called motor car equipment such as gasoline, gasoline electric and oil electric type units including streamline train power units are now being supervised by our inspectors and tests and inspections made and reports filed with the Bureau of Locomotive Inspection by the carriers operating such equipment. As the boilers used for heating and other purposes are undoubtedly under your supervision, I am quite sure that you all are familiarizing yourselves with the rules so that a proper compliance may be had and unsafe conditions properly and promptly repaired.

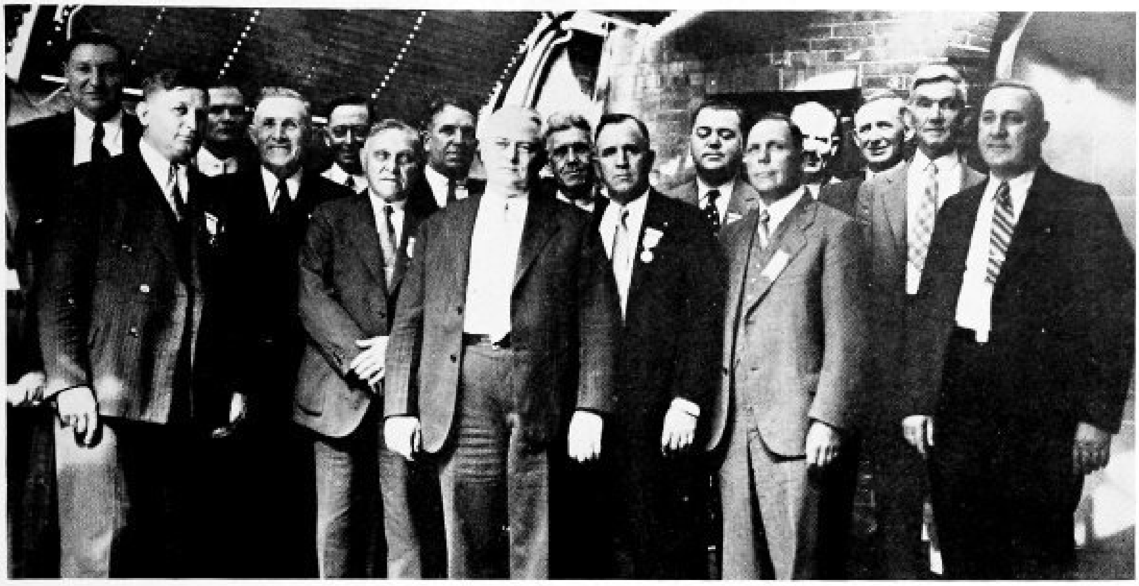
Please note that rules 300 to 327, inclusive, apply to "Boilers used in connection with locomotives other than those propelled by steam power," only.

As some misunderstanding has arisen as to what fuel-oil reservoirs are referred to in rule 324, will advise that that part of the rule relating to hydrostatic test and hammer test does not apply to gasoline tanks used in connection with internal-combustion engines, in other words, the reference to fuel-oil reservoirs in rule 324 refers to oil storage tanks or reservoirs used in connection with boilers.

While the locomotive is performing its term of service between general shoppings careful and thorough inspections, workmanlike repairs to such parts as need attention, and proper and sufficiently frequent boiler washing that will not only remove sludge and scale-forming matter but that will hold the foaming tendency of the boiler water within reasonable bounds as well, will insure economical operation and the greatest attainable degree of safety. I include boiler washing to reduce the foaming tendency of the boiler water because it too often happens in misguided efforts to save the cost of boiler washing, which is usually an investment in safety and economy rather than an expense, that this feature is not given the consideration its importance deserves, with the result that those on or about the locomotive when in operation are subjected to unnecessary danger due to inability to ascertain and control the water level. It might be stated here that Section 2 of the Locomotive Inspection Act makes it unlawful for any carrier to use, or permit to be used on its line, any boiler that is not safe to operate, and that Rule 45 requires that boilers be thoroughly washed as often as the water conditions require.

Many of those in charge of maintenance of locomotives do not take full advantage of the opportunity afforded by the daily inspection reports to keep informed of the sufficiency and effectiveness of the repairs applied or work done at the end of each trip. We often find that the same defects or work required are repeatedly reported on successive trips, usually accompanied by some evidence that attempts had been made to remedy the conditions reported. This should be ample warning that the methods followed were not effective, that progress is not being made in eliminating or alleviating the conditions reported, and that time and money is being wasted. Master boiler makers who want to improve the service and at the same time reduce costs, (and they all do), will find a fertile field in this direction.

Our inspectors are in the field to promote the safety of employees and travelers upon railroads so far as this can be accomplished through having locomotives in proper condition and safe to operate. Our inspectors are your friends, but it must be understood that they are going to find things and report them if they are not right; when occasion requires our inspectors take just the action you would have done had you been in a position to exercise your free and independent judgment rather than feeling constrained to get a few more trips from the boiler before applying needed repairs. We realize that such difficulties as these, which fortunately are comparatively few and far between, are seldom the fault of the master boiler makers; we appreciate your co-operation and have every hope for its continuance.



Chief Inspector John M. Hall, Kearn E. Fogerty, president of the Association, A. F. Stiglmeier, secretary and W. H. Laughridge, treasurer, with a group of federal inspectors in attendance at the meeting

Naturally there is always some uncertainty as to future policy in the minds of many of those who may be affected after a change in administration of any activity, such as the recent change in the Bureau of Locomotive Inspection by which I was advanced from the position of assistant chief inspector to the position of chief inspector. I wish to take this occasion to assure you that my sole purpose will be to enforce the law and rules in a broad, fair, and impersonal manner, bearing in mind at all times that our only duty is to promote safety. It will be our further purpose—and when I say "our" it means the entire Bureau of Locomotive Inspection, so to conduct our work that we will merit the full assistance and co-operation of your association, and of each individual member.

M. B. M. A. Business Sessions

(Continued from page 266)

gained, to his fellow men. It is only through mass action that we accomplish the best results for mankind, and we should all strive to accomplish that end.

This is probably the last convention I will ever have the opportunity to attend. Father Time has been exceedingly kind to me and my associates as a whole have been extremely kind to me,—people that I have had to deal with have dealt very kindly with me. But we cannot turn back the hands of Time. I have reached the age in life when it is said it is necessary for me to retire, —not because I want to, not because I believe I'm done, but the law says I must go.

While I have addressed the convention on many occasions, and have taken part in the discussions, I have differed with you on many subjects. They were honest differences. I have given you the best advice that I had. I have devoted my entire life for nearly twenty-five years trying to improve the condition of locomotive boilers and the motive power of the railroads. My endeavor has been to promote the safety of operation of locomotives. In the process and as a result of the improvements made the efficiency and economy of operation of the railroads have I believe been increased.

Thursday Afternoon Session

Topic No. 3, "Staybolt Leakage and Cracking of Firebox Sheets," prepared by a committee consisting of M. V. Milton, chief boiler inspector, Canadian National Railways, chairman; C. W. Buffington, general master boiler maker, Chesapeake & Ohio Railway Company, and J. J. Powers, general system boiler maker, Chicago & North Western Railway Company, was presented at the opening of the Thursday afternoon session. This report and discussion appear on page 287.

Topic No. 4, "Application and Maintenance of Arch and Water Tubes," was next presented by a committee consisting of W. N. Moore, general foreman boiler maker, Pere Marquette Railway; C. A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis Railway, and R. A. Pearson, general boiler inspector, Canadian Pacific Railway Company. The report appears on page 293.

Election of Officers

The election of officers was next held with the following results: President, O. H. Kurlfinke; first vice-president, Franklin T. Litz; second vice-president, Ira J. Pool; third vice-president, L. E. Hart; fourth vice-president, William N. Moore, fifth vice-president, C. A. Harper; secretary, Albert F. Stiglmeier, and treasurer, William H. Laughridge. Executive Board: C. J. Klein, M. V. Milton, J. C. Callahan, and E. C. Umlauf.

The entire list of officers for the coming year, with their railroad connections, appears on page 263.

The 1935 meeting concluded with the presentation of the past presidents' badge to Kearn E. Fogerty, retiring president, by John A. Doarnberger, general master boiler maker, Norfolk & Western Railway Company, who also is a past president of the association. Mr. Doarnberger also praised the secretary, Albert F. Stiglmeier, for his untiring efforts, in behalf of the association, and Mrs. Stiglmeier, who has worked long and faithfully in assisting the secretary to carry on his duties. A rising vote of thanks of the entire association was tendered to them.

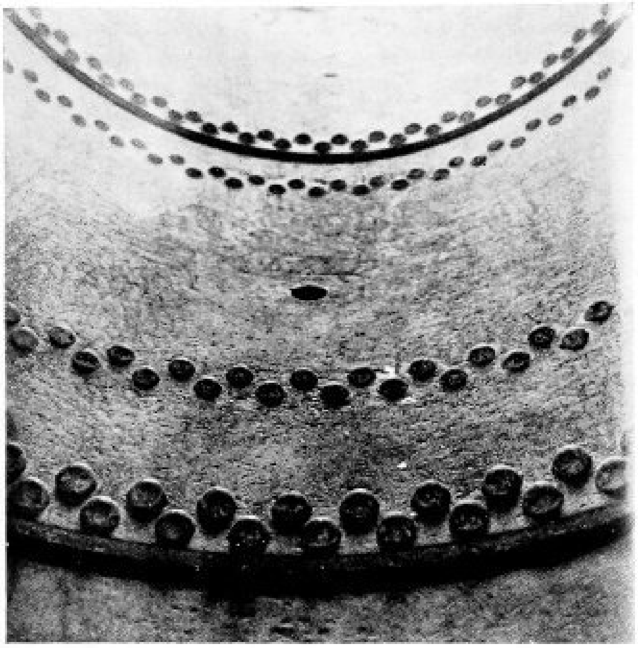
The list of members and guests registered, as well as the entire membership list appear on page 297.

A meeting of the Ladies' Auxiliary of the Master Boiler Makers' Association was also held.

Complete committee reports and their discussions, as previously noted, appear on the following pages.

Problem for boilers in service and in storage of

BOILER AND TENDER PITTING AND CORROSION



Oxygen corrosion on boiler shell

Committee

J. L. Callahan

E. J. Reardon

A. W. Novak

Pitting and corrosion of boilers have been a source of discussion ever since the inception of this organization, although in the early days our chief concern was with scale formation and pitting. Firebox and tube life were gaged by the amount of scale-forming solids in the various water supplies, with pitting confined to certain areas, principally in the coal and ore mining districts.

As scale was responsible for the bulk of boiler maintenance, the problem then became one of water treatment. It was soon found that by keeping the boiler water in an alkaline condition at all times, pitting caused by acid waters was easily arrested.

Inasmuch as scale and pitting were the result of water conditions, the two problems became associated as one and any reference to either was under the heading of water treatment. Through the efforts of the master boiler makers and the attention directed towards boiler problems as a result of water, more attention was given to the question of treatment. It can, therefore, be said that the boiler makers were really the instigators and aggressors in promoting the use of treatment, with the result there is hardly a locomotive in this country which is not, in some manner, receiving some form of water treatment.

The railroad managements were quick to see the advantage of proper treatment with the result that we now have highly trained chemical engineers who have specialized in locomotive water treatment and to whom we can now pass our problems. Through their efforts and with our co-operation, scale formation has been reduced, resulting in longer firebox life. Tube life has been increased from six months and a year, or with approximately 35,000 miles, to a full four years and longer with from 250,000 to more than 400,000 miles between tube removals.

It must be admitted that the efforts expended in scale elimination have, in a great degree, been responsible for the large savings effected in boiler repairs and made it possible for our department to operate successfully during the most trying years that the railroads have ever experienced. Our water engineers are to be congratulated for a job well done.

As scale elimination became less of a mystery, water service and chemical engineers attacked the question of pitting and corrosion. Many of our boiler makers assumed an attitude that anything that would "eat up scale would eat up steel." It is regrettable but nevertheless true that this same feeling still exists with some among our profession. It is probably because of this attitude that very little progress has been made. While pitting and corrosion have, in a small degree, received our attention, we have not, as an organization, been overly active in assisting towards a solution. This is undoubtedly due to the fact that our own problems have taken up most of our time and probably because of lack of meetings of the association and lack of organization in directing attention to the most serious of conditions which our department has to meet.

We, as an organization, have listened to authorities advance many theories as to the possible reasons for this condition and have been told of the effects to be expected on the various parts of the boiler. We have even been requested on a number of occasions, as an organization, to assist in a study of corrosion of metals by securing all possible data as to type, location and effects produced in the metals involved. The requests apparently have been ignored. We now find our department confronted with a problem which has grown so

Note: The committee which submitted this report is composed of the following members: J. L. Callahan, general boiler inspector, Chicago Great Western Railroad Company, chairman; E. J. Reardon, service engineer, Locomotive Firebox Company; A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific Railroad Company.

rapidly in the past few years that now we *must* become interested in seeking a solution.

Because of our contact with the water engineers, we have attained a fairly good working knowledge of water treatment, to the extent that we are generally familiar with the names of the various chemicals and their effects. We have seen the reactions and effects of water treatment in the removal of scale and the benefits gained therefrom. We have at the same time found, with a decrease in scale, an increase in pitting. Treating of water has not eliminated pitting and corrosion. In fact where the external treatment has been put into effect, pitting and corrosion have become more noticeable. This may, in some cases, be due to the scale acting as a protection and upon its removal the metal would be exposed.

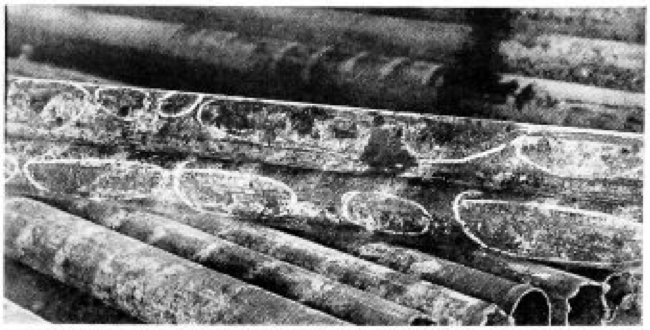
Pitting and corrosion in locomotive boilers are nothing new. We have had the same complaints with respect to pitted tubes, grooving of the tubes at the front flue sheet, grooving around radials and staybolts at the fire sheets, pitting and grooving of the barrel courses below the water line. We still continue to scrap tubes and apply shell courses and new fireboxes as before. Our complaint is that there has been little, if any, advancement in the locomotive field in the elimination of these evils.

Conditions causing corrosion are numerous, but the principal causes are dissolved gases, corrosive salts, acidity and electrolytic action. The stationary field was long confronted with the same problems and usually the troubles were corrected. Corrosive salts and acidity are generally the results of chemical reaction in the water. Dissolved gases, particularly oxygen, are believed to be the most common causes of corrosion and pitting in medium pressure boilers. The action of each is very easily determined; acid corrosion being a scaling or roughing of the metal, while oxygen corrosion is in the form of a V-shaped pit.

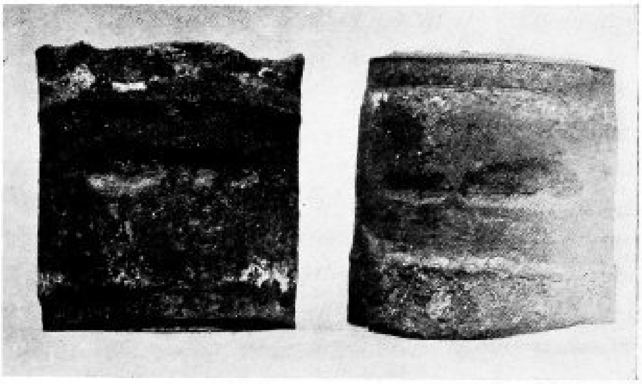
Electrolytic action is the result of two dissimilar metals being joined together at two points. By heating one junction to a temperature different from the other there will be a difference in electrical potential between the two, resulting in a flow of current. We have this action produced in our locomotive pyrometer which we have occasion to observe almost daily. If one junction becomes corroded so as to form an imperfect contact, there will be an actual jumping across of electric current through the boiler water, resulting in the boiler water separating into its ions, forming hydrogen or hydroxide ions. In the presence of sodium chloride (common salt), which we have in all boiler waters, there will be a breaking up into sodium and chlorine, forming hydro-chloric acid. Electrolytic action is undoubtedly the cause of the grooving encountered around the tubes at the front tube sheet, grooving of the shell courses in the rear of girth seams and around the radials and staybolts on the fire sheets, as well as in the plates along the mud ring.

In the stationary field, oxygen is removed by means of an open feed-water heater, a de-aerator, or by chemical means. Sodium sulphite, tannins and chromates are reported to be very beneficial. Acid effects in the boiler can be completely neutralized by maintaining an alkaline condition in the boiler water. Ordinarily an alkalinity sufficiently high to prevent scale will also inhibit corrosion, if the corrosion is caused by acids or by salts giving acid reactions.

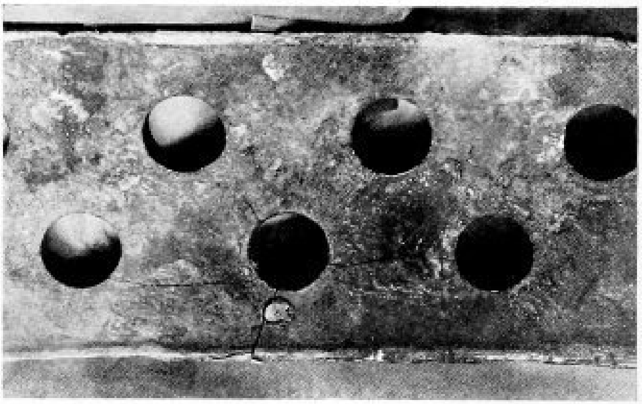
Electrolytic or galvanic action corrosion has been controlled by zinc plates suspended in the boiler water and a good electrical contact made by the zinc and iron



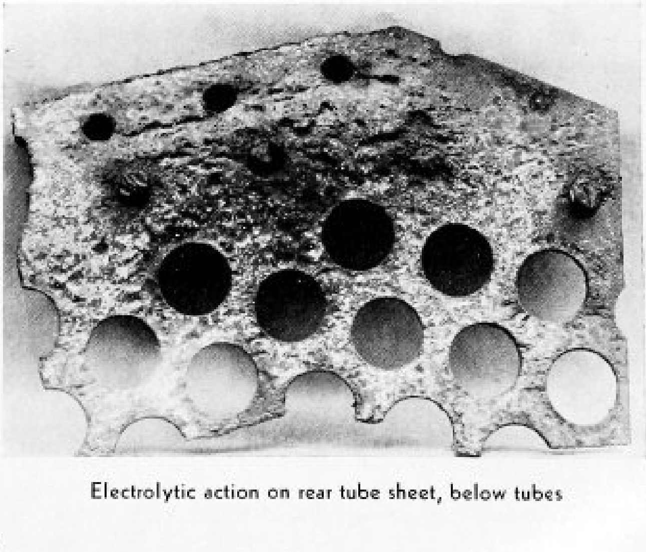
Acid corrosion on tubes



Electrolytic action — ring worming of tubes at front tube sheet



Caustic embrittlement on girth seam



Electrolytic action on rear tube sheet, below tubes on the boiler shell. The hydrogen liberated by electrolytic action passes out with the steam. The zinc plates must be renewed after being consumed by the oxygen.

It is realized that the problems of the stationary boiler differ greatly from those of the locomotive boiler and in many cases the methods applied could not be adapted to locomotives. However, the advance in that field is worthy of consideration and warrants the attention of the railroad chemical and mechanical staffs.

The question is often asked, "Why do not welds made by the electric-arc process corrode?" We find that such is the case, and cannot offer a reason. It would appear from the progress made in producing electrodes of the shielded-arc type, both acid proof and equal in every respect to the physical tests required of boiler plates under A. A. R. specifications, that consideration should be given to the use of this material in the welding of pits or grooves on boiler shells or in the so-called "unstayed surfaces."

It is recommended that the American Society of Mechanical Engineers Boiler Code, the Association of American Railroads Standards and the Bureau of Locomotive Inspection rule, "safe and suitable" be revised to permit welding of pits or grooves in locomotive boiler shells or, at least, permit experimental work of such nature. Such welding would be done by a qualified welder and only upon approval of the Federal locomotive inspector, and the responsible boiler supervisor.

In a summary of reports received from the membership, it is found that the life of tubes has been materially advanced in locomotives assigned to pitting and corrosion territories, due to assignment of power to long runs that require passing over two or more divisions. Tube leakage has been less and scrappage of tubes due to corrosion has, in many instances, been reduced 75 percent.

An effort has been made to advance shell and tube life through the application of protective coatings. The spraying of various types of metals in the form of brass, zinc, copper or lead on the plate surface by the oxy-acetylene process is undergoing experiment. There are but little data available as to the results as a protection against corrosion in boilers. The operation is very expensive and the results are questionable.

During the past five years, a number of railroads have had under test a protective coating which is painted onto the plates and tubes after they have been thoroughly sand-blasted to remove all scale and mill slag. Inspection of plates and tubes after four and five years of service showed the coating still on the plates and tubes and no evidence of corrosion. It was found that scale would not adhere to the same extent, as to metal which had not been coated. Boilers are found to clean easily, and it is not necessary to resort to air scaling tools in scale removal. The material tends to promote an even distribution of heat over the entire heating surface. It has long been in use in the stationary field and is highly recommended by leading stationary boiler manufacturers and stationary boiler insurance companies. It is believed worthy of consideration for locomotive use.

In the past few years a new evil has arisen in the form of cracking of shell plates at girth seams and straps. In some cases rivet heads have cracked off. This condition has been termed "caustic embrittlement" and is the result of insufficient sodium sulphate in the boiler water, in the presence of causticity.

There are very few cases on record where definite proof has been established that the cracking of plates in locomotive boilers was the result of "caustic embrittlement." This is probably due to the fact that locomotives usually receive various supplies of water while in service.

Many water engineers and chemists differ as to the real cause of embrittlement, and question whether it is the result of water treatment or structural defect. As far as investigation discloses, cracking of plates seems to exist only where the metals have been joined together with the rivets having been driven on a hydraulic press. It is believed that the term "caustic embrittlement" has been highly commercialized and many boiler users are now attempting to avert a condition that does not and will probably never occur.

It is believed that the problem is largely one of structural stress as a result of excess hydraulic pressure in riveting. In testimony of this, it has been reported that "cracking of plates at girth and horizontal seams has never been encountered when riveting was done by hand or long-stroke hammer."

In the prevention of pitting and corrosion of boilers and tenders in storage, several methods have been reported as follows:

Anti-corrosion mixtures may be applied and allowed to remain in the boiler or tender for several hours to form a coating and then drained out.

An application of 50 gallons of fuel oil may be made to the boiler, which is then filled with water. Allow the mixture to stand several hours in order to coat the plates thoroughly and then drain. Before the boiler is returned to service it should be thoroughly boiled out with a strong solution of caustic soda and then washed out to prevent foaming.

Where climatic conditions permit, boilers are completely filled with water and allowed to stand. In other cases a prepared solution of soda ash and water may be applied and allowed to remain in the boiler for the full period of storage.

Boilers may be drained and a chemical solution sprayed over the sheets and tubes.

When the tubes are removed, the interior of the boiler may be sand-blasted and covered with a protective coating.

The general practice in storing locomotive boilers is to blow the boiler down hot and remove a few washout plugs to permit drying. A tender to be stored should be drained and the manhole closed.

It is believed that, inasmuch as corrosion found in a certain territory affects the boilers of all railroads operating in that territory, a great deal might be accomplished towards its elimination by having sectional meetings, at more or less frequent intervals, of all boiler supervisors of the district to discuss the problems encountered.

This association could aid materially by appointing a standing committee to receive reports from such sectional committees and work in conjunction with the water service section of the Association of American Railroads.

With the development of new ferrous materials for use in the construction of high-pressure boilers, we should be alert to the many changes that will arise.

A standing committee of this association could bring to the members information that would not be available other than through magazines, business meetings or conventions.

Chairman's Introduction to Discussion

J. L. Callahan: As chairman of the committee, I have taken the liberty to invite a number of water service engineers of the Association of American Railroads to be present in order to bring out as many points as possible with respect to corrosion. We realize that every railroad has had problems with respect to pitting and grooving of shell courses, various parts of the boiler, and it is hoped that a frank discussion will be had on this particular subject.

Discussion

Elmer E. Owens (Union Pacific): Pitting and corrosion, in the last ten or twelve years, has been greatly reduced on our lines. This has been accomplished mostly by water treatment. We use wayside treating plants and a water softener. This compound, which includes sodium aluminate in its composition, has done more to eliminate pitting during the three or four years of its use than anything that has been introduced during my time. It not only has helped us reduce the pitting and corrosion of flues and boiler plates, but also of water tanks. When we store an engine we put in a strong solution of this compound and allow it to stand a few hours; then drain it out. It acts something as did oil in the old days. It adheres to the sheets and forms a protective coating, and apparently prevents rust. Most of our trouble on tanks comes from cracking. I find in our large tanks and cisterns (we use the Vanderbilt cylinder type tank) that cracks develop at the bottom of the stoker trough in the corners. This is not the result of corrosion of the sheets except in the rectangular tanks, where it occurs at the top of the angles and on the sides and on the bottom. The vibration of the sheet opens up seams and allows corrosion and grooving. A lot of this has been overcome in the last three or four years through the use of anti-corrosion compound.

During the last five years pitting on flues has been reduced fully 50 percent. Our main trouble now is with grooving at the front flue sheet caused by vibration of the flue.

H. H. Service (Santa Fe): We have reduced pitting conditions on the Santa Fe Railroad with better water treatment, along with extended runs and better boiler washing out conditions. In 1930 we scrapped 2270 superheater flues, as compared with 1023 in 1934. In 1930, 13,723 flues 2¼ inches in diameter were scrapped and in 1934 only 6023. In regard to storing locomotives, we have been blowing the locomotives down while hot, leaving out the washout plugs, and permitting them to dry. That is the only procedure we have taken. In regard to anti-corrosion mixtures, we have not tried any of them to my knowledge. Tenders are drained, manholes closed and permitted to remain in that manner without cleaning out the tank until the boiler or tank is placed back in service, at which time it is thoroughly cleaned. Grooving and pitting of tanks is one of our biggest problems. We have grooving, as referred to by Mr. Owens, at the top of the bottom angle along the sides of the tanks. It is a grooving action caused by oscillations of the tank, combined with the pitting condition. The sheets, when cleaned off, in that location show pits over the entire surface. The inside of the plate comes in contact with soda ash lime treated water and we find very little difference in the tanks as far as pitting is concerned following internal or external treatment; it is general.

J. L. Callahan: In our investigation, we could get no information with respect to corrosion of tenders. In my opinion, the care of the tender is a responsibility equal to that of the locomotive. The one surprising thing is that, while we are all using water treatment of an alkaline nature, we still have a coating of scale form on the sides of the tender plates. At the same time, when the scale is knocked off, we find our plates will be badly pitted.

I understand in connection with the various protective coatings that attempts have been made to apply an asphaltum base material on the tenders, but anything in the form of a water treatment seems to destroy that coating and has a tendency to peel, just the same as any alkaline material applied to any painted surface will fade it or peel it off.

C. W. Buffington (Chesapeake & Ohio): We have had a great improvement in the last ten years. Our water is about 70 percent treated. Flues and boiler work conditions have changed. Whereas we seldom were able to get full four years' service out of flues, we now sometimes get full four years plus special extensions. Improvement in general boiler work has been just as good. We now sand-blast the barrel of the boiler and coat the boiler with a solution of Portland cement and sand; spray it on with a gun. When the engine is fired up we use soda ash or lime. This cleans the boiler and starts a slight coating as protection.

H. A. Bell (Burlington): I represent the Burlington on the lines West. The territory is contiguous to the Union Pacific and probably some Santa Fe territory. Our pitting conditions and the percentage of flues scrapped are greater now than in past years. We do not have any trouble from scale forming. In the report mention is made of flues grooving at the front end. We have this condition not so much at the front end, but at the back end just ahead of the fire bar. We have had flues practically pit off at that point. There were no other defects in the flues. We scrap more than 40 percent of all the flues that are removed on the lines west. I keep a complete record of all flues removed, with the number pitted, the number pit welded, the number in good condition and the number to be cut down, etc.

We have tried several different methods of controlling pitting and corrosion. Some of our engines are equipped with the electro-chemical method. In two cases it has reduced the trouble, but in two other cases there is little difference over locomotives not so equipped.

We have had better success with lengthening the life of the flues and firebox sheets, also the boiler sheets, by transferring engines from one division or one water district to another after a short term of service.

The committee mentioned a material to spray on the boilers after they are sand-blasted. I am very much interested and would like further information on the process.

J. L. Callahan: There are several preparations available in the form of paint with a graphite base. The material that we have found to be most successful is known as Apexior. It is recommended by the various leading boiler insurance companies and by the large boiler manufacturing companies. Public utilities are now standardizing on its use, especially in high-pressure watertube boilers of from 1000 to 1800 pounds pressure.

Sigurd Christopherson (New Haven): In regard to the Apexior paint, on the New Haven two years ago we applied it to a full set of flues, although we do not have any pitting or corrosion. We have scale. On inspecting the flues after two years' time, we found the Apexior coating to be intact. We also tried Apexior on a few of the flash boilers installed in our electric locomotives for heating purposes. On heating boilers we experience quite a lot of peeling, owing to the galvanic action, but very little corrosion so far has developed. These boilers have been in service for sixteen months. In the case of metal spray, which we have also tried on these boilers, pitting and corrosion apparently are not prevented. I know that the Boston & Maine Railroad has tried out the metal spray without any degree of success.

With regard to the locomotive boiler and tender storage, we are blowing boilers down hot, removing the washout plugs. We use dry soda ash in the boiler, removing the dome cover, and allowing the dry soda ash to go wherever it will to cover every plate and every flue in the boiler. We also clean out the firebox, including any coal behind the grate and side bar. Then we spray behind the side bars with old lubricating oil from automobiles. We also clean the front ends and spray them with oil.

On our tenders, after they have been cleaned and all the coal is removed, we use a continental cement on the outside. For the inside, we drain the tank, drop the tank hose and leave the manhole cover open so that the air will circulate through it, and we have good results.

With reference to statements that electric welding does not show corrosion or pitting, our railroad has been using the acetylene process for the last sixteen or eighteen years, both in firebox and other work. We have never found any corrosion or pitting on oxy-acetylene welds.

Lewis Nicholas (Monon): During the last few years we have used different treatments for keeping boilers clean that have practically eliminated the pitting of our flues. We have a little towards the smokebox.

Mention was made of flues grooving off in the prosser mark at the back of the flue sheet. I have seen a good bit of that in places where, in my opinion, it was caused by using a short bead prosser. Tool manufacturers supply a tool they call a half-inch prosser for a half-inch sheet. If that tool is used it will cut off the flues even at 9⁄16 inch. To eliminate this, I have found it necessary to go to a 5⁄8-inch prosser expander.

M. V. Milton (Canadian National): We are internal treatment men. We never had enough money in Canada to buy outside treatment. We do have trouble with pitting and I do not think we will ever be free of it, because I believe the human element governs the causes a great deal. Many of us are daily going to the master mechanic to get the engineers to blow down their boilers. Excess sodas are to a certain degree required, but not to the extent that the engineer allows them to concentrate by not blowing his boiler.

As far as the tanks and engines are concerned, when not in service, I believe that most of us have taken care of it by allowing the air to circulate freely through these vessels.

H. E. May (Illinois Central): On the Illinois Central we have in a measure whipped pitting and corrosion by proper boiler treatment. We use both internal and external treatment. On our stored boilers, we have but very few that are stored with any miles to amount to anything. We take out the flues and use them and clean the boilers, sand blast them, and put a coating on the boiler shells. The tanks are left empty. We do not find any ill effect from letting them stay that way.

Boilers having new flues, that are stored, and with a low mileage, are kept full of water with a soda ash solution—about 50 pounds of soda ash to three thousand gallons of water. This keeps the scale soft to a certain extent. Before the boiler is put in service it is thoroughly washed. The blowing down of boilers has helped our railroad a great deal. We wash boilers as often as conditions require, but we do a great deal of blowing down, knowing that our boilers are not operated with a high foaming salt. We have a laboratory for testing water at each point at which the engines are maintained and dispatched. A water sample is taken from each boiler at the end of each day's work and that water is tested. The boiler is then blown down sufficiently to bring the foaming salts away below the foaming point. I believe that the blowing of boilers properly has done more to correct a bad condition in boilers than boiler treatment itself—or as much. They both go hand in hand and one is no good without the other.

J. M. Stoner (New York Central): Speaking for the main line of the New York Central, particularly the lines west of Buffalo, our troubles from pitting and corrosion are nominal. While we have a few flues that corrode off at the front flue sheet, and some pitting experience has taught us that by adding some new material to the forward end of the bottom flues, during classified repairs, the practice will forestall much of the corrosion. Care must be exercised in setting flues not to stress the material too much. Power machine rolling with long extended rolls has a tendency to open up the fiber of the material and permit active corrosive agents to attack the metal.

In storing locomotive boilers, our practice has been to steam the boiler up to maximum temperature and pressure and blow it off, permitting the heat to absorb all the moisture, and not opening up the boiler any more than to the extent of removing one front corner washout plug. In the event that moisture does collect it can drain out freely. Oxygen is one of the principal agents of corrosion. If you can eliminate that from the boiler or from the tank, your battle is half won. The principal precaution to take in storing a boiler or a tank is to be sure that all sludge and refuse material is taken out of the foundation. If it is allowed to remain it will cause pitting.

A. W. Novak (Milwaukee): Due to the many kinds of water, some of which are unsuitable and frequently objectionable for boiler purposes, the locomotive designer and the boiler maker are faced with problems caused by scale accumulations which, together with other factors, develop into corrosion and pitting and eventually cause leakage.

If excessive or too rapid expansion or contraction is allowed to occur, the whole fabric of the boiler is severely strained and it is only a matter of time before some part must give way. If scale exists, boiler parts become overheated because scale is a non-conductor. As the expansion varies with the temperature, it is easily seen what the effect will be.

It must be remembered that metals lose much of their strength and toughness at the higher temperatures. In addition, if scale contains sulphate of lime, this will hydrolyze when hot enough, with the formation of sulphuric acid which attacks the metal, resulting in corrosion.

This behavior explains in some cases the pitting under a layer of scale. Also when expansion takes place there may be a slight separation of seams, allowing scale to form in such places. When the boiler cools, the scale will not allow the parts to come together as originally, so this alternate expansion and contraction permits more and more scale to form, the condition continuing to grow worse.

It is to be noted that scale, once formed, acts as a nucleus or center about which more gathers. It is therefore evident that the stability and long life of the boiler is best secured by adopting means that will eliminate the causes of excessive and rapid expansion and contraction and of the corrosion of the different parts of the boiler at their origin.

The practical way is to provide good water, avoid excessive expansion and contraction by keeping the temperatures of the boiler parts within reasonable limits. This can be done by using hot water for washing, by taking reasonable time for cooling down and abstaining from generating steam too quickly.

Some of the principal factors effecting corrosion and pitting is the material used. The use of two different metals should be avoided and as nearly the same quality of any one metal should be used, this because in the manufacture of iron or steel it is difficult to produce material the same throughout and the poorer the grade the greater the difference between specific points.

When ingots of steel are cast, the elements other than iron separate in different parts of the ingot in varying amounts as solidification takes place. This is notably the case with carbon, sulphur, phosphorous and, to a lesser extent, with manganese.

Consequently, when a sheet is rolled or a flue drawn, it is of a varying composition at different points. It is therefore necessary that extreme care must be taken in the manufacture and in the testing and inspection before delivery or acceptance. The composition of the steel itself is most important with regard to its resistance to corrosion.

In addition to the troubles brought about by unsuitable qualities of steel, the various kinds of water have their influences, corrosion is also inaugurated and accelerated by oxygen and carbon dioxide, both contained in the air, entrained in the feed water. The latter of course exists dissolved in all natural waters. If these gases can be removed, it is evident that corrosion incident thereto would be prevented.

R. Sennif, chemical engineer (Alton): We have had quite a little experience on the Alton with corrosion. We use an internal treatment with soda ash. After the water treatment was first inaugurated, a good deal of corrosion occurred.

Late in 1927 we decided that about a half dozen isolated water supplies were causing most of the trouble from corrosion on the line. One very notorious supply was at Bloomington, Ill., where yard engines experienced flue failures at about nine months and came in for a new set in maybe eighteen months or two years, after having enough flues renewed in the roundhouse to make between two and three complete sets. We treated that water at times with as high as 4.5 pounds of soda ash per thousand gallons. We kept town the scale all right, but the corrosion was terrific.

An interesting thing arose at Bloomington which pointed out one way of corrosion prevention to us. A battery of Sterling type stationary boilers is located at that point using the same feed water from the same water tank, and the same type of treatment. Whereas locomotive boiler flues failed nine months after their application, the stationary boilers ran year after year with no pitting whatsoever. As far as I can remember, since 1924 there has not been a tube or a sheet renewed in those stationary boilers on account of corrosion or pitting.

The only difference between the conditions was that the stationary boilers had a good open type feed-water heater on the feed line, which removed practically all of the dissolved oxygen and carbon dioxide. That substantiates Dr. Koyl's theory that good feed-water heaters will prevent corrosion. At the same time, maintain high alkalinity in the water and pitting will be reduced.

Corrosion is seldom due to any one specific thing; it is a combination of things. The first remedy which any railroad can apply is to maintain a uniform, constant, high alkalinity in the boiler water. After you get to a pretty high alkalinity, corrosion seems to decline in general in proportion to the increase in alkalinity.

If on top of high alkalinity we could deaerate the feed water, I would say 80 percent of your corrosion would be corrected. That solution, however, still remains in the future.

Another thing is care in working the metal. Corrosion might not take place with bad boiler water if all the boiler was under about the same stress and contained about the same type of metal. If you stress a piece of boiler metal you do about the same thing as putting in a different kind of metal. The stressed part assumes different characteristics than the unstressed part, and corrosion is apt to be set up at the stressed point. Great care in the application of sheets and tubes should be exercised to avoid overworking and overstressing. This should eliminate a lot of trouble, particularly the grooving of tubes at the sheets.

An important item mentioned several times is sand-blasting to remove mill scale and black oxide. These impurities have very different characteristics, electrolytically, from the tube itself, and under proper conditions will start a pit in the boiler metal.

Sand-blasting removes black oxide and scale and gives you a new start on your tube. There, in my estimation lies the chief value of sand-blasting and the more thoroughly it is done, the better off we will be.

The fifth way in which we can improve our corrosive condition, and a very hard way, too, I have found, is in improvement of water supplies. Management seems to be very reluctant to spend any money to change water supplies. We have found that it paid good dividends at Bloomington, for instance, to improve the water supply there for it eliminated the corrosion problem entirely.

Another thing that is worrying me a great deal right now is the condition of our locomotives in storage. I am afraid we are going to find a whole lot of rust and a whole lot of pitting started in these boilers that have been out of service during the depression. A lot of study should be given to the protection of boilers in storage. A good many suggestions have been offered. Some of them are fairly effective. Perhaps the best method would be, if weather conditions permit, to fill the boiler with an alkaline solution of some kind. It is just as important to protect boilers awaiting repairs as while awaiting service, because we ruin a lot of flues that could be re-applied merely by letting them set out on the dead line and rust away.

Another matter of utmost importance is to keep a detailed record of the conditions of corrosion on boiler materials removed for any purpose but particularly because of corrosion, including flues and sheets. Staybolts removed because of corrosion should also be reported. The record should cover the condition of the material removed, location in the boiler and the date, and it should be carried on from shopping to shopping.

The water engineer does not know what the symptoms are unless he knows the condition of corrosion, severity, location in the boiler, where the locomotive has been working, how it was equipped, whether it had arch tubes, siphons, feed-water heaters, etc. Some of our roads are keeping such records and I think they have found the practice very beneficial.

Caustic embrittlement is extremely rare in locomotive boilers due to varied water supply and to the design of the boiler itself. However, I think it would be very wise for a boiler foreman, in observing a condition which he believes might be caustic embrittlement, to try to interest someone higher up in an investigation of the matter.

R. C. Bardwell, service engineer (Chesapeake & Ohio): I want to take this occasion to thank Mr. Callahan for this privilege of meeting with you gentlemen once again and also for the invitation he extended to the Water Service Committee of the American Railway Engineering Association to be present and hear this discussion. The report is indeed a most excellent report and the discussion has been very helpful to all of us.

We have had fairly good luck in overcoming pitting and corrosion on the Chesapeake & Ohio by simply applying the means and information available. There are very few cases of pitting and corrosion that cannot be solved if somebody takes the time and trouble to get down to the bottom of the particular case.

Most of the pitting and corrosion that now seems to be giving trouble is due to dissolved gases more than it is to any other one thing. In the old days there used to be scales or acids in the water, but since most of the railroads have gone to some form of water treatment, keeping their scale troubles at a minimum, the sheets are cleaner. When the sheets are cleaner, they are exposed to the action of these dissolved acids in the water. The elimination and correction of that part of the trouble is the real problem. The water engineers and chemists on the American Railway Engineering Association Water Service Committee have made a number of studies of this subject and to date our conclusion is that the best method for holding pitting and corrosion at the minimum is by keeping a high alkalinity in the water.

So far as danger of so-called caustic embrittlement is concerned, you have all undoubtedly heard a great deal about that subject and I believe that each and every one of you probably know just about as much about it as anybody else. There has been no cure figured out for it yet because nobody has as yet definitely proven that there is such a disease. The investigation being carried on at the Bureau of Mines Experiment Station at New Brunswick, N. J., during the past three years, seems to have proven fairly definitely that the old theory about caustic embrittlement protection by sodium sulphate may or may not be true. That is one of the problems that is still before us, and as water chemists are working on it, we hope to get to the bottom of it sooner or later but we will have to admit that we haven't done so yet.

To do this we need the co-operation of the boiler makers. The chemist by himself, when it comes to water treatment, may think he is making a showing but it really doesn't amount to much unless he has the help and co-operation of the boiler makers. With that co-operation and by working together, we can really get some place. They have shown it can be done.

R. E. Coughlan, water service engineer (North Western): It was about fifteen years ago that we water engineers were first invited to sit in with the boiler makers. At that time one of the big problems was scale and we also were confronted with the problem of pitting and corrosion under the scale. Now from the discussion that we have listened to here today, apparently the scale is licked but we still have the corrosion and some of you gentlemen have definitely stated that when we eliminate the scale we increase the pitting.

This undoubtedly is true because in eliminating scale we put a definite electrolyte in the water, sulphate of soda. It has been definitely proven that sulphate of soda does aggravate corrosion and the solution to that is an increased alkalinity. High alkalinity causes caustic embrittlement, the solution being sulphate of soda.

My first experience with caustic embrittlement occurred about 1914 along the shores of Lake Michigan extending up into our territory, which goes up along Lake Superior. The boilers were cracked. That was the evidence. The water was good. We were putting a little soda ash into it to keep the boilers from leaking. The boilers were clean.

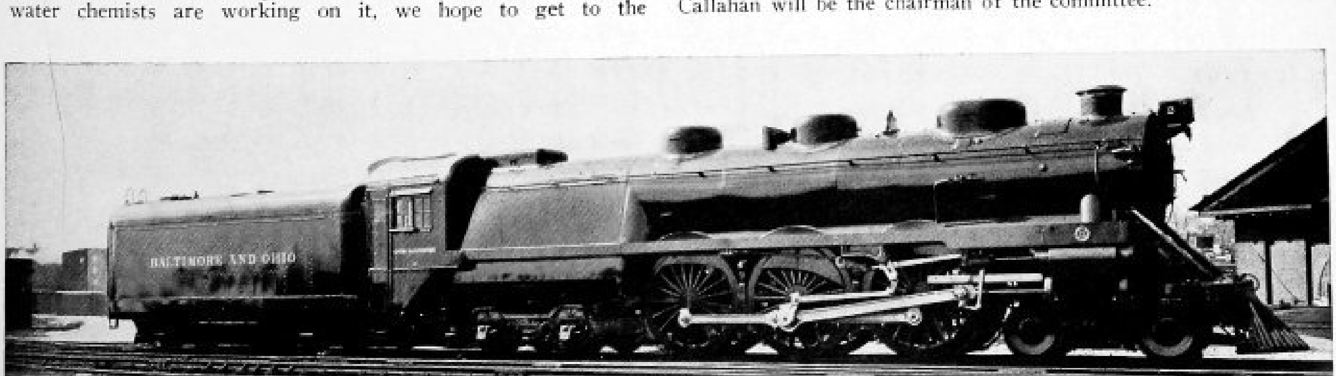
In the next two years we made some six thousand analyses of the concentrated boiler water and in every case but one we found that the so-called cure was being applied but still the boilers cracked. In other words, the operation was successful but the patient died.

We then went into the organic end of it and in one particular year, I think it was 1916, we had as high as thirty-seven boilers crack. After we went into the organic treatment, which consisted primarily of an oxygen absorbent known as tannin, along with a little phosphate, our cracking was reduced down to less than one a year until the last five years when I think we had three boilers crack under the butt strap, rivet hole to rivet hole.

Being vitally interested in this problem, I attended every session I could of the Bureau of Mines and also got all the information I could from the various universities, and the more we learned about the work that was being done, the more we found out that we didn't know anything at all about it; that it was just a phenomenon which is as yet unexplained although a very serious one,—so much so that many of our boiler makers carry a magnifying glass today and examine the sheets on the inside, especially around the rivet holes, under the butt straps, to be sure they are not overlooking the effects of this serious problem.

Tank corrosion is an entirely different problem than the corrosion you get at boiler temperatures. You have a cold water corrosion. When you put in treated water, as you all know, you put in one form of lime to take out another one. When you do that you also absorb or try to absorb all of the gases, primarily carbon dioxide. As far as our experience has gone, the problem of tank corrosion simmers down to a problem of applying the proper protective coating.

President Fogerty: In the chairman's report there is a recommendation for a standing committee to work with the Water Service Committee of the American Railway Engineering Association. I am going to appoint the present committee on Topic No. 1 to work with that committee on water conditions. Mr. Callahan will be the chairman of the committee.



Modern power — The Lord Baltimore

Application to locomotive boilers and tenders of

FUSION WELDING

Your committee finds that the rapid advance of railroad practice in the past twenty-five years can be attributed in great measure to improvements in the methods and facilities employed in building and operating locomotives. One of the most important factors in the successive stages of improvement of motive power has been the development, approaching the point of perfection in technique of fusion welding as applied to locomotives, particularly in the construction of fireboxes, the welding of flue sheets, the application of patches in the side and crown sheets, and the welding of flues.

The various forms of electric fusion welding as are practised today, have been known for more than half a century. The apparatus in use today for forming or producing the Voltaic arc between the metals to be operated on and the conductor, brought for this purpose in the proper proximity to the welding point on the metals, is very similar to that sketched by the original inventors of electric-arc welding. Fig. 1.

The various types of joints, such as lap welds, bevel butt welds, reinforced strap welds and many others, were used by the pioneers in the art, and it is surprising to find that so much was known about electric welding so long before it was generally adopted in this country.

Note: The committee which submitted this report is composed of the following members: Ira J. Pool, district boiler inspector, Baltimore & Ohio Railroad, chairman; L. C. Ruber, superintendent boiler department, The Baldwin Locomotive Works; H. H. Service, general boiler inspector, Atchison, Topeka & Santa Fe Railroad.

Committee

Ira J. Pool

L. C. Ruber

H. H. Service

Information regarding early types of electric welding apparatus and methods can be found in U. S. Patent Paper No. 363320, issued to Messrs. Benardos and Olszewki, who were subjects of the Russian Czar. They owned many foreign patents on this art, which were issued to them in 1885.

The accompanying illustrations reproduced from their patent papers show types of welds that were made and apparatus used for making them.

Fusion welding of firebox seams has now been adopted by the majority of railroads. Its success can be attributed largely to the conscientiousness and the ability of the supervisors and operators.

The original types of riveted firebox seams were both expensive and troublesome due to the necessary thickness of metal, which caused overheating and consequent development of cracks. This trouble has been practically eliminated by fusion welding with the resultant economy in both maintenance and construction.

Practically all firebox construction is now being made with the butt type fusion-welded seam.

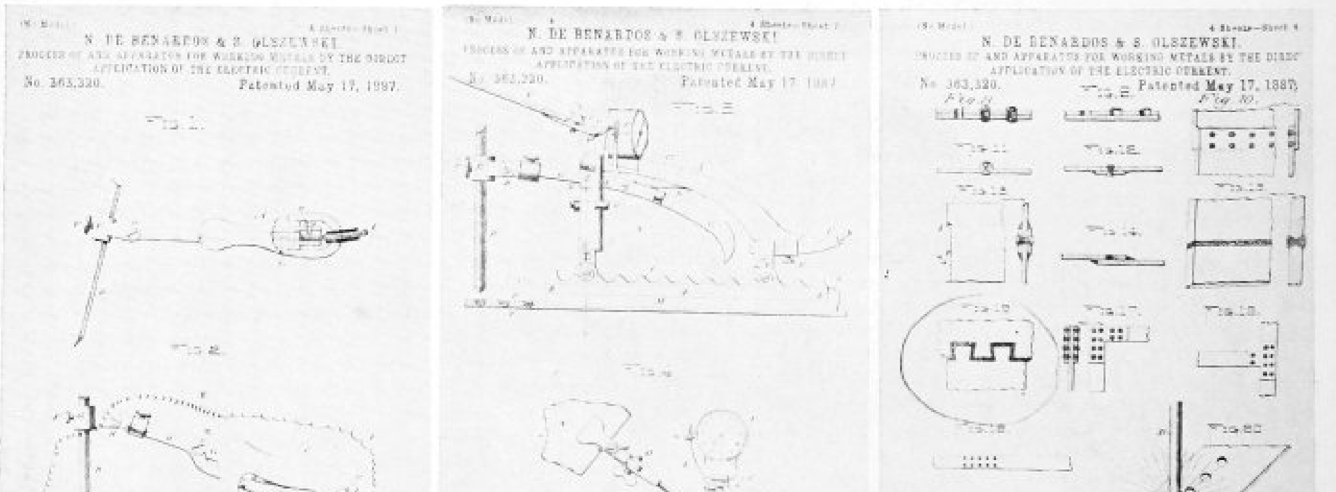


Fig. 1.—Reproductions of original U. S. Patent, covering arc welding apparatus, in 1887

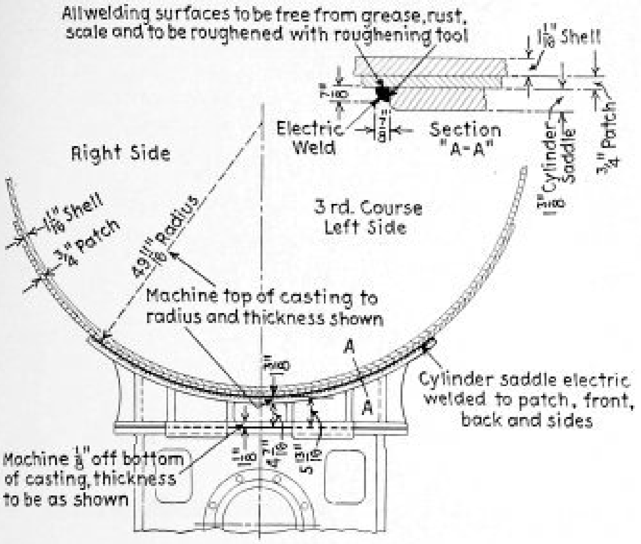


Fig. 2.—Welded saddle liner on simple Mallet locomotive boiler

Welding rods for welding different alloys have been so highly developed by the manufacturers that any problem which arises can easily be solved by consulting with the manufacturer of the rods.

Coated electrodes are used by many authorities in all welding when the work is subjected to pressures on materials 3/8 inch in thickness and over, for many reasons such as:

Greater efficiency in the welded joint.

Much easier for the operator to handle after he has had sufficient experience in welding with this type of rod.

Greater tensile strength and greater elongation.

Less porosity in welds.

In the use of coated electrodes, extreme care must be taken to see that all foreign matter is thoroughly cleaned out after each layer of material has been deposited.

In the application of sleeves and caps for flexible staybolts, the electric welding process for welding the sleeve or cap to boilers has almost superseded the use of the threaded sleeves.

Locomotive boiler tubes and flues were first welded generally to tube sheets by the electric-arc process in 1909. This process is now estimated to reduce tube and flue maintenance approximately 300 percent.

The welding of the fire door holes in boilers is now almost universal.

One railroad has a simple Mallet type locomotive in service with the No. 2 cylinder saddle and the boiler bearer castings electrically welded to a liner, Fig. 2, which is riveted to the barrel of the boiler especially for this purpose. This practice eliminates the use of a cylinder saddle and boiler bearer bolts and holes in the barrel of the boiler. Freedom of leakage from these sources is of material advantage. This locomotive has been in service for almost two years. The illustration herewith shows the manner in which the cylinder saddle and boiler bearers are prepared and the method used for welding.

Some of the railroads of the United States have adopted as a standard the welded type of tank and are getting excellent results. The initial cost of this type might be slightly in excess of the old riveted type, but the cost of maintenance is probably less over a given period of time of operation. This is a subject which the members of the Association on whose railroads the welded type of tank has been adopted should give their experience for the benefit of those who thus far have not tried out the welding of tanks.

It is very difficult at this time to furnish information in electric welding which has not been covered in previous reports on welding. Most railroads now have definite codes and instructions for welding, which largely are the result of the extensive efforts of the Master Boiler Makers' Association.

It is hoped that in the discussion of this report, the broad experience of our members in the application of welding during the past five years will develop new ideas, and permit this association to continue as an important contributor to the fund of knowledge on this subject, which has proven so valuable to the railroads of the country.

Recommendations for the application to locomotive boilers and tenders of

FUSION WELDING*

Your various committees from time to time have made reports governing their findings as to the standard practices followed on many railroads throughout the United States. Your present committee also finds that many of these practices are still in use and being followed with very efficient results, especially so far as fireboxes of steam boilers are concerned.

Improvements have been developed and put into practice; that is, when a design of repair did not appear to give the desired results, a change in design was made, which proved more satisfactory.

*The committee which submitted this report consisted of the following: H. H. Service, general boiler inspector, Atchison, Topeka & Santa Fe, chairman; L. M. Stewart, general boiler inspector, Atlantic Coast Line; M. A. Thompson, welding supervisor, Boston & Maine; J. J. Davey, general boiler inspector, Northern Pacific; F. C. Hasse, general manager, Oxweld Railroad Service Company. This report was published in the "Convention in Print" issue of The Boiler Maker, October, 1933.

Committee

H. H. Service

L. M. Stewart

M. A. Thompson

J. J. Davey

F. C. Hasse

May we first mention that it is very important that all concerned, or those responsible for fusion welding on steam pressure boilers and tenders, including supervisors, instructors and inspectors, should be thoroughly familiar with the process and standards as they apply to their respective railroads.

All master boiler makers will agree that one of the important parts of the entire welding process is the qualifications of the welder. Therefore, it is of vital importance when selecting student welders that care be exercised in selecting the proper kind of men. The first requisite is that he should be a mechanic, also he should be of a type that will make every effort to improve and develop the process and its application.

The fusion welding industry has come to its position gradually. We have seen the wonderful development and improvement in apparatus, equipment, welding rod, and, most important, engineering, metallurgy and chemistry.

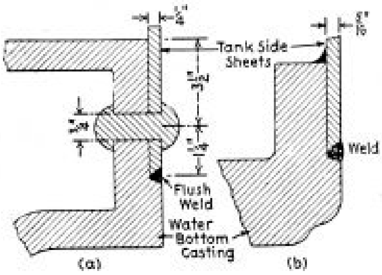


Fig. 1

Consider for a moment the expense involved in setting up a job preparatory for welding, and then analyze the small cost of the welding rod per pound against any other part of the job, the cost of the equipment, and the cost of preparation, and it will be found that if the welding rod cost $2 a pound, was of the proper quality, met all specifications, was properly applied and the welds held, it was cheap at any price; but if a rod of inferior quality or unknown quality was used, principally because it was cheaper by a few cents a pound, and you had a failure, then the poor rod becomes very expensive.

Practical standards should include general instructions, as well as approved drawings showing the proper application of sheets, patches, syphons, and complete fireboxes, as well as the welding of miscellaneous parts.

It is also important that a proper bevel is made on the sheets and that correct and uniform openings are allowed in the setting up of the sheets for welding. The speed with which welds can be executed is materially retarded, if the work is not properly prepared.

The joining of sheets in locomotive fireboxes by fusion welding has been adopted on practically all railroads. The process most commonly used is the electric arc, while oxy-acetylene is also extensively used.

The butt weld, with sheets beveled on the fire side, is the recognized and preferred type of joint used. Wherever it is possible, the weld is reinforced on the opposite side of the bevel. In preparing firebox sheets for welding, an opening of from 1/8 to 3/16 inch should be allowed between the sheets to obtain the full penetration of the weld. Where the shielded arc electrodes are used, closer fitting is necessary and an opening of 1/16 inch between sheets is sufficient. The bevel on each sheet should not be less than 30 degrees.

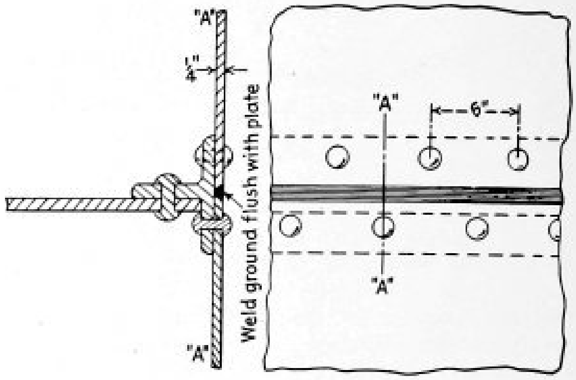


Fig. 3

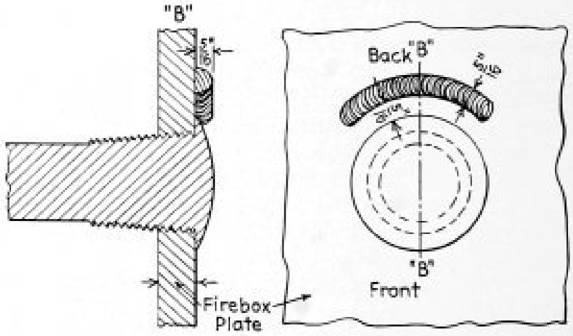


Fig. 4

After clamping the sheets in place, they should be tacked at sufficiently close intervals to hold them properly in place while welding. All necessary tacking should be done before the welding is started, to prevent the sheets from being drawn out of line and also to hold a uniform opening between the sheets to secure proper penetration.

Many of the above mentioned practices have been, and now are, standard rules laid down for welders and those involved in preparing parts to be welded. They are again mentioned because your committee feels that their importance cannot be emphasized too greatly. Consequently, they may be considered as a repetition of previous reports. Nevertheless they are used in this report because of their vital importance in the success of fusion welding.

In the matter of welding locomotive oil tanks and tenders to replace the former practice of riveting, some railroads now use the all-welded type of construction, and up to this time it has proved satisfactory. Other railroads have resorted to a combination of riveted and welded construction, which has also given satisfactory results.

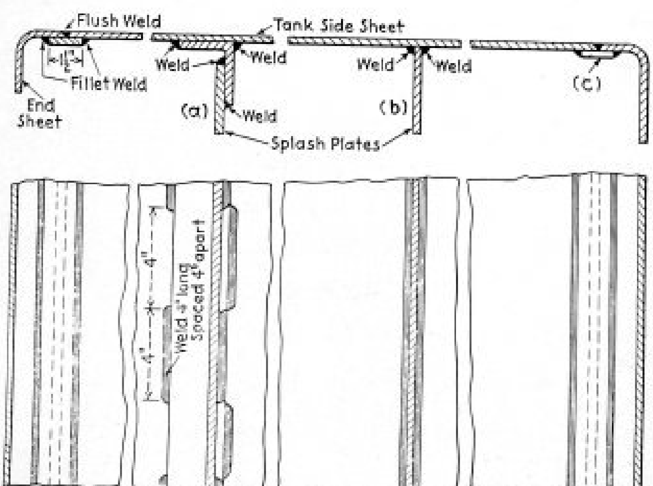


Fig. 2

Where cast-steel frames of the water bottom type are used, some railroads are welding the outside plates to the cast-steel underframe, the sheets being welded at the bottom edge to the frame on the outside where it laps over the casting. They are also fillet welded to the casting on the inside, thereby eliminating the possibility of water getting between the sheets and casting and starting corrosion, as may be the case if the weld is not made on the water side. This construction also acts as a stiffener to support the sides. See Fig. 1(b)

Where the combination of welded and riveted construction is used, this same type of welded joint is made, except that the fillet welding on the water side of the tank is omitted, and the rivets are spaced above the bottom horizontal weld. See Fig. 1(a).

Stiffening angles, cross-braces and splash plates are applied in the all-welded construction, as outlined in Fig 2(a) and (b), where rivets are entirely eliminated. When judging the stiffening effect of the construction as outlined in Fig. 2(a), it occurs to your committee that this design is most desirable. There are features in favor of the construction shown in Fig. 2(b), such as lightness of construction and lower cost of application, which may be preferred in the construction of lighter tanks. However, sufficient comparative service has not been rendered for your committee to be justified in making any recommendations as to which type of construction could be recommended as a standard practice.

Your committee does not at this time wish to have it understood that this construction is uppermost in design as far as the welded tank is concerned. They have discussed its features only as far as their investigation has gone, and take the privilege at this time of asking other members what results they have obtained along these lines of construction, so that all concerned may be informed as to what progress has been made.

Fig. 2(c) shows the type of vertical seam being used in some designs of water tank cisterns. In this design the welt strap is placed on the water side of the plate, which has a tendency to produce a stiffening effect on the flat vertical sides of the tank plate.

Where repairs are made to the present riveted type of tank construction, there are times when it is necessary to remove large plates, especially in the sides of tank cisterns, in order to repair the defect and maintain their uniform appearance. Before fusion welding was developed, large sections were usually riveted in place, the cost of which was high. The cost of this class of repair has been greatly reduced because smaller sheets are now welded between the horizontal riveted seams of angle or tee braces, as outlined in Fig. 3, following the center line of braces and not changing the appearance of the outer portion of the tank where the section is applied. Some railroads now consider it a standard practice to insert the lower one-third section in this manner as it becomes necessary.

Fig. 4 shows a fusion welded rib which is applied to the fire side of firebox plates where cinder cutting is causing the heads of staybolts to be cut away. These ribs are welded in place while the water is in the boiler, and have the effect of minimizing the cinder cutting action on the fire ends of the bolts.

The chairman of your committee wishes to advise that the fusion welding process is also being utilized in the smoke arches of locomotives to prevent air leaks. The front end angles are now welded into place, instead of being riveted or bolted.

Your committee also reports that certain types of washout plug bushings are being successfully welded in the outer casing sheets. The same may be said regarding flexible staybolt welded type sleeves.

Discussion

Ira J. Pool, chairman (Baltimore & Ohio): With the approval of the meeting, we will include in the discussion the report on this subject which was contained in our "Convention in Print," issue of The Boiler Maker, October, 1933, and which therefore has not before been the subject of discussion. (The report in question appears on page 277.)

H. H. Service (Santa Fe): I would like to ask some of the members who have all-welded tank construction as to the procedure they follow in making their seams? Do they hold the plates in place to prevent warping while the work is in progress?

Lewis Nicholas (Monon Route): I would like to ask Mr. Service what success he is having with the shielded arc or heavy coated wire in vertical and horizontal welding?

H. H. Service: In firebox work we have not used the shielded-arc process. We have had demonstrators in our shops who have welded flues with the shielded-arc process. They have not been in service long enough for me to determine the results.

For the past twenty years most of you have been using the fusion welding process in one way or another. The same practices presented to this association as far back as 1922 are still standard with a few exceptions where changes in design have been made to improve the service or performance of fireboxes. Extended runs have kept firebox temperatures more uniform. Better water treatment and a good many other things have gone into extending the life of fireboxes.

However, good rivets and good welding rod with careful workmanship have done much to assure long service without failures.

William N. Moore (Pere Marquette): We are following the standard practices as outlined on the various railroads for fitting up and sanding and so on, and our results are very good.

A question was asked this morning by a member about the cracking of welded flues in the back flue sheet, the cracks extending from the bead in to the sheet. We have found on our road that, by running the engine a few minutes before welding the flues, we have been able to remedy this trouble to a great extent.

A. F. Stiglmeier (New York Central): Welding today seems to be undergoing somewhat of a revolution due to the fact that we have a coated rod, different than was used years ago. Many representatives from the wire people will visit our railroad officials telling them of the speed they can get with the coated rod—which is a fact. No doubt this is quite interesting to our officials in these times of depression. I believe it is the duty of this organization thoroughly to discuss the characteristics of the coated rod, and try to develop the information as to whether or not a rod in reversed polarity gives the best results in boiler work. Also, what its merits are in welding flue beads to the sheet. One of the features of this coated rod is speed. Are we not trying to weld flue beads to the sheet a little too fast? Is not that perhaps the cause of the beads cracking? Are not expansion and contraction too great? On our railroad we have experienced difficulty with the coated rod in reversed polarity on flue work. After a fair trial we have found the bare rod better suited for this work; i.e., welding flue beads to the sheet. One of the difficulties we have encountered with the coated rod in reversed polarity, was that the rod would penetrate too deeply, and in some instances, make contact with the copper in the flue hole.

Members having information available on the subject of coated welding rods of reversed polarity should take part in the discussion.

President Fogerty (C.B.&Q.): In applying coppers I believe they should be extended back on the sheet 1/16 inch. Then when you roll it, they come out practically flush. After doing this, when welding flues there is no trouble from drawing the copper.

Ira J. Pool: On the Baltimore & Ohio we are now about to turn out two engines with the flues applied without any copper ferrules. We are applying these flues without prossering them or beading them. The hole is drilled to suit the flue without the copper ferrule, which automatically increases the width of the bridge. Then the flue is belled over to 45 degrees. We weld around the belled-over end of the flue.

As I say, we are just turning out these two engines, but we feel that this method of application will be beneficial. Years ago we welded flues with hot water in the boiler and we have started that practice again. We believe it will tend to control the heat penetration and eliminate the starting of bridge cracking and probably help out on the fire cracking of flues. At the next meeting we will be able to report any benefits derived.

H. H. Service: In regard to coppers projecting from beads on flues, the arc must penetrate the metal and, if the copper is there, it will draw, whether the shielded arc or any other is used. The coppers must be kept back. Reversed polarity with the shielded-arc process, of course penetrates slightly deeper. That is one of the principal reasons why you must fit plates closer.

In regard to Mr. Pool's remarks, of welding flues in two engines with the ends of flues flared out, I might say that the Santa Fe did some of this work from 1908 to 1913 on what was known as Jacob's superheaters. However, the work was done by the oxy-acetylene process and all welding was done downhanded. Nevertheless, the work did not stand up, which of course, could not be termed as a black eye against the oxy-acetylene process of today. Nevertheless, it did not work out satisfactorily, and I might add that later on this superheater arrangement was termed "Jacob's refrigerator."

By all mean keep hot water in the boiler when welding flues. About 90 degrees F. is our practice.

J. A. Doarnberger (Norfolk & Western): It is a well-known fact that the first completely electrically welded locomotive firebox ever built in this country was the old 778 in July, 1914, at the Roanoke shops of the Norfolk & Western Railroad. That engine is still running but we must go further.

When the Lukens Steel Company put in their 212-inch mill, they only guaranteed to roll 196-inch width sheets. About five years ago we built twenty Mallets carrying 300 pounds pressure with fireboxes for which we wanted sheets 214 inches long. The best we could get was 196, so that left us slack about 18 inches. We solved this problem by welding a triangular piece in the sheet to give us the required size for forming the firebox.

We are now starting on a group of engines of still greater dimensions. For this order we require a sheet 22 feet 4½ inches wide, to be exact, and still the best we can get is 196 inches. This leaves 72 inches short on the width to build this firebox with a 96-inch combustion chamber. Flues for this boiler are 24 feet 2¾ inches in length. The locomotive will operate at a working pressure of 300 pounds per square inch.

What we will have to do is obtain the largest sheets possible and weld them together. That is our only salvation. The work must of course be done with the best welding rod and technique.

Instead of building a firebox with four sheets—two side sheets, crown sheet and bottom of combustion chamber—we have adopted the one-piece sheet. Our only means for building such a firebox is electric welding. It has come to stay.

Wonderful progress has been made. I have always predicted and the time is coming when we will be allowed to weld any part of the stayed portion of the boiler. We have kept off the barrel sheets, but believe me, barrel sheets will be welded just as other pressure vessels.

E. E. Owens (Union Pacific): I have five sets of 3½-inch flues applied without any coppers, and I did not prosser them in the sheet. I beaded them with an ordinary beading tool and welded them on application. One set has now made about 50-000 miles, and there has not been a leaky flue up to date.

We have districts where we have cracks develop from the beads lengthwise into the flue. When the flue vibrates and loosens in the sheet throwing the stress all on the weld, scale forms in the space. This becomes overheated and causes fire cracks. There are no more fire cracks there than there are in a seam. Flues because they are welded cannot be forgotten. When inspection shows them to be loose tighten them in the hole and you will overcome fire cracking. In some districts you will have to do it oftener than in others. I have districts where we have completely treated water, in California, for instance, where I can run the flues for a year without expanding. In Oregon I have to expand them every thirty days.

When I went up there five years ago, we were getting 45,000 to 50,000 miles on flues. We were taking them out because they were fire cracked. Today we require 100,000 miles from flues and we are making it.

I have one bad condition over on the Union Pacific in our coal burners. That is with cinder cutting. If it were not for welding, I would not get 50,000 miles out of the flues in these locomotives. These are Type E superheated boilers, with 262 flues in the set. In about 16 or 18 months the beads are cut off. The only way I can save them is to catch them before they get too thin and build them up with welding. The reason I did away with coppers is that I did not want too much material at the ends. I wanted a straight flue so that the prosser mark would not catch the cinders.

President Fogerty: Has not your road adopted the idea of lowering the arch tube at the back end and carrying a longer arch to help eliminate cinder cutting?

E. E. Owens: We have one engine, a 9,000 type, that now has 90,000 miles. We lowered the arch in the door sheet about 10¾ inches. When cinder cutting first started we carried seven courses in our brick arches. The cinder cutting developed so fast we lowered that to six courses, which slowed it up some. On the engine in which we lowered the arch, I have 90,000 miles. I will make 150,000 miles more easily than 90,000 miles with other engines on which the arch tubes have not been lowered. I have authority now to lower them in 10 more engines.

I am also going to extend it to our Mountain type, where we will lower tube 8½ inches. In these five engines that I have equipped without any coppers, I increased the thickness of the flue sheet 1/16 inch in order to give more bearing and withstand cinder cutting longer. They have not been in service long enough to determine how long they will run.

President Fogerty: I also believe you have had some trouble on arch tubes leaking at the door sheet and you have helped considerably by building up on the sheet ⅜ inch with electric welding.

E. E. Owens: About ten years ago the Southern Pacific was doing our work at Ogden. We were running our engines to Evanston. I was sent out there because Ogden could not turn out power fast enough. I went to see what was the matter, and in every case found it would be an arch tube leaking in the door sheet. So I went back to Evanston and started pulling out arch tubes. I found that the tubes were being almost cut off by the sheet. I reinforced the hole with ¼-inch boss around it; reamed it out and put the tube back. This eliminated our trouble in the door sheet.

Sometimes one became loose in the throat sheet, so I built them up on both ends. That is my present practice. I make a ⅝-inch bearing at either end. I have also done away with the copper around the arch tube, putting arch tubes in close-fitting holes, reinforced by the ⅝-inch bearing. Then the tubes are rolled metal to metal. They are tight enough so that any expansion and contraction will go in the curvature of the tube and take care of it.

J. W. Kelly (National Tube Company): In my travels I recently saw an interesting development along the lines of Mr. Owen's practice. The boiler maker doing the work, punches a small hole in the sheet, and with a small die flanges the door sheet and the flue sheet towards the fire. He does not do any welding, but just presses the hole out like the old flue hole in the flange fire.

O. H. Kurlfinke (Southern Pacific): Mr. Service mentioned the fact that the practice on the Southern Pacific is to set tubes without copper ferrules. He is right. We experimented for years endeavoring to get a tube, especially the Type A superheater tube, to stay tight. The oxy-acetylene process years ago would not work. Later on when electric arc welding became popular, it was more successful. Still we had trouble. Tubes working in the boiler coupled with expansion actually pushed out through the back tube sheets and broke the welds.

It brought us to the point where we had to prosser all tubes. At first, we could not get a prosser or a man or an air hammer strong enough to expand the tubes. The practice was never successful until one of our general foremen conceived the idea of having the tube prossered hot in a machine, a safe end about 8 inches long. It makes a very good prosser. It is very high,—I would say ¼ inch, with the face of it touching the inside of the back tube sheet practically square with the sheet, with a very small fillet of about 1/16 inch taking care of the corner where it enters the tube hole.

The surface of the firebox side of these sheets was countersunk with a bevel of 45 degrees ¼ inch deep or one-half the thickness of the plate. The tube then was belled out, and the end welded to the sheet. There was no projection of the weld on the firebox side. Those sheets are practically flush. We do not permit the men to build the weld up.

Later on when the Type E superheater came into being we did the same thing without any experimentation at all.

I mention this to illustrate the wonderful success that we are getting with these big engines in that the tubes will run their life. We are having absolutely no trouble with leaky superheater tubes. We do follow the practice on the small tubes of running the engines until the tubes give us trouble. We do not weld them in the beginning, but we found out from ex-

(*Continued on page 286*)

Safety in the operation of locomotive boilers increased by the multiple application of

BOILER DROP PLUGS*

***By O. H. Kurlfinke*†**

While it may be expected that all persons affiliated with the manufacture, operation and repair of steam boilers have at one time or another discussed fusible plugs and their reliability to function at the opportune time, I believe it necessary to review in a brief way the many disappointments experienced in the past when using a fire-actuated fusible plug as a means of warning to prevent boiler disasters, with the result that in some quarters their use has not advanced very far.

The designs vary, because of the efforts made to effect improvement in their operation. In the majority of these cases, and perhaps all, the fusible metal consisted of a solid core. The usual design is shown in Fig. 1.

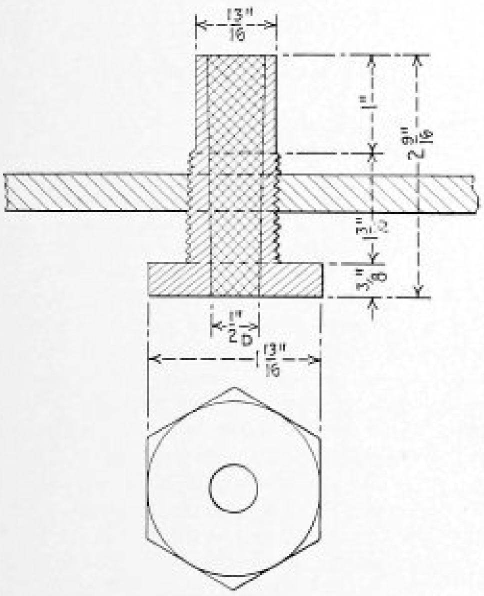


Fig. 1

Another design, shown in Fig. 2, was used for a period between 1903 and 1915. This design was thought to be an improvement over the design shown in Fig. 1.

The experience in both cases was that the plugs had to be renewed at least once every two months, because the alloy metal disintegrated to the extent that the plug would not function, regardless of the temperature reached. In many cases the alloy metal could be cut with a knife and instead of peeling off in chips, exposing a bright metallic surface, it would break up or crumble, resembling a sort of hard clay mixture.

In other instances where the plugs were still in good condition it was found, in several cases of low water that although the plug was duly heated, the alloy metal would start to melt, and before the entire body of alloy metal would drop out, the action of the steam through the small opening first made had the tendency to cool off the metal to the extent that the plug would not properly fuse. The result was that the plug became practically useless and therefore unreliable.

Adhering to the theory that fire-actuated fusible plugs are sound in principle and provide an economical method by which to forestall damage to firebox crown sheets on account of low water, further research developed the design of plug illustrated by Fig. 3.

In this instance the objectionable features above explained were eliminated by the application of a drop plug button, which was cemented in place with fusible metal. Therefore, the fusible plug heretofore always referred

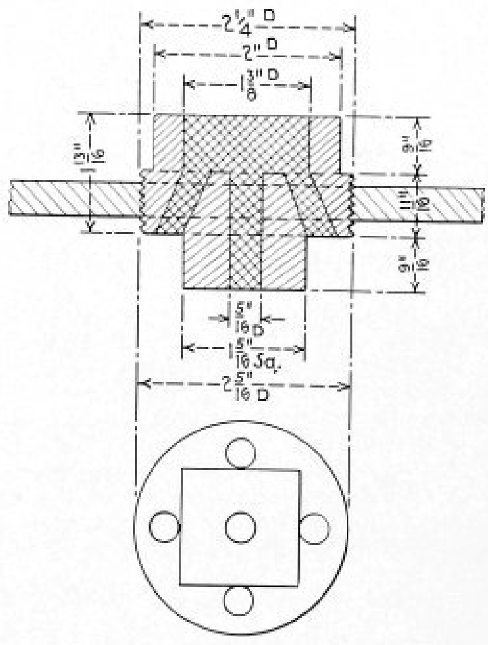


Fig. 2

to as such, has developed into a practical drop plug. In other words, the boiler pressure forces the button out of the hole instantly when the alloy metal fuses, and the full unrestricted opening for the escape of steam is thus obtained. Experience with the use of this plug since 1915 has conclusively demonstrated that the design of this drop plug is fundamentally sound. In some cases their functioning under normal conditions, when the crown sheet was fully covered, was somewhat erratic. At any rate, the deficiency was on the safe side.

This deficiency to a large extent was caused by plugs not being manufactured at a central point on the railroad using them, resulting in slight variations from exact dimensions governing the relative diameters of the hole in the plug. The consistency of the alloy metal was not always exact, and the method of handling the plugs

* Special report covering the performance of boiler drop plugs applied to locomotives operated on the Southern Pacific Company, Pacific Lines.

† Boiler engineer, Southern Pacific Company.

after the button had been sweated in place impaired their consistent operation.

Up to the latter part of 1931, several boiler explosions were experienced and the conclusion reached, at the time investigations were held to determine the exact contributory causes of these accidents, was the plugs should be made and so applied as to number and location that they would function in a positive manner. This to the extent that the escape of steam therefrom would have the effect of driving the heat of the fire away from the ceiling of the firebox so the crown sheet would not be subjected to the full heat of combustion, thereby preventing the crown sheet from becoming overheated.

In the latter part of 1931 further improvement in the design and manufacture of this drop plug was made with a view to obtaining the objective that, when the plugs fused, the fire would be so interfered with it would be difficult and perhaps impossible for anyone to continue to manipulate any device that would continue the operation of the locomotive under such conditions.

The drop plug thus designed and perfected is shown in Fig. 4.

In general appearance, the plugs shown in Figs. 3 and 4 are similar; but particular attention is invited to the dimensions governing the application of the button. During the period when the plug shown in Fig. 4 was being developed, the conclusion was reached that the diameter of the button should be enlarged from ½ inch to ⅝ inch. This change increased the area of the opening 56 percent. The reason for doing this was to increase the load on the button at a given boiler pressure, so the button would drop out of the plug in the event the boiler was fired up without sufficient water over the crown sheet and full boiler pressure had not yet been reached.

A further advantage of the ⅝-inch diameter opening in the plug is that much more steam will be admitted to the firebox when the plugs fuse. With the ⅝-inch diameter opening, experience has shown it to be of ample size, for in cases of low water it has been found that the sheet in the vicinity of the plug location is not discolored and bears no evidence of having become overheated.

It was also considered necessary to increase the thickness of fusible metal between the button and the plug body. The plug shown in Fig. 3 had 0.001 inch thickness of fusible metal around the button. The plug illustrated in Fig. 4 has 0.003 inch thickness of fusible metal. The reason for this increase was that oxidation has a deteriorating effect on the fusible metal and the more rapidly fusible metal is heated and cooled down the more rapid becomes the process of oxidation.

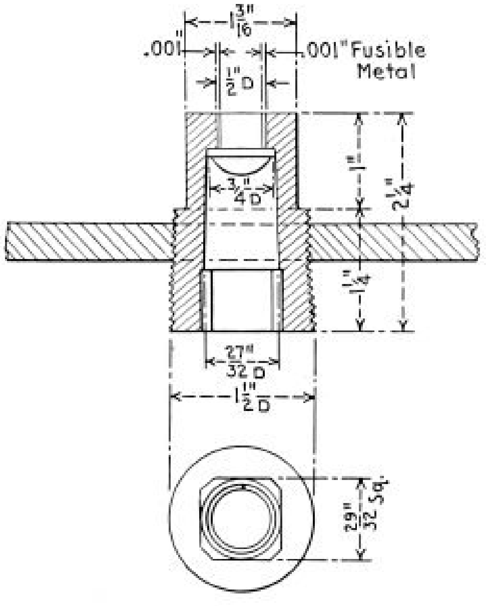


Fig. 3

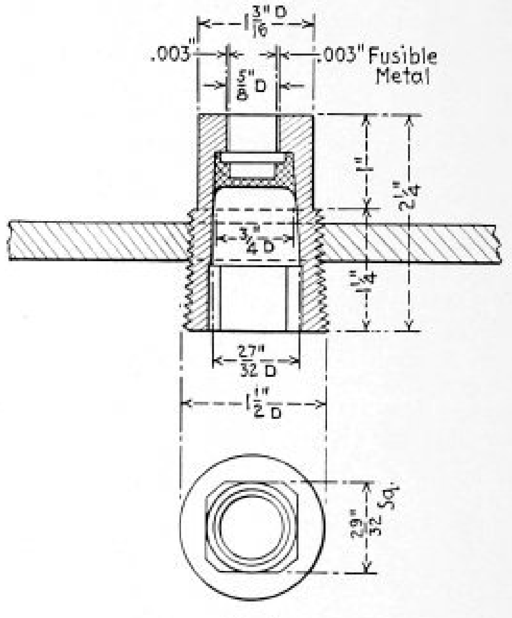


Fig. 4

As these drop plugs fuse due to rise in temperature through the plug body, the larger the button diameter (of course within certain limitations) the more rapidly the plug will function under the same boiler pressure. For instance, when the heat gradually increases, the fusible metal will begin to soften and, when it reaches a certain degree of softness, the pressure on the button will force it out of the plug body. Where a boiler is fired up without sufficient water and pressure in the boiler is very low, the thickness of fusible metal is such that it will melt to a liquid state, and, in so doing, the button will fall out at the first indication of a load upon it. As the pressure gradually increases and the plugs fuse in multiple, the hazard of accident is less likely, since the higher the pressure becomes, the greater also becomes the volume of escaping steam. Within a short time the disturbance thus created will direct the attention of the man in charge to the fact that something is wrong.

From the foregoing, one can easily visualize the effectiveness of the button-equipped drop plug compared with the solid alloy metal fusible plug, and the improvement in design of the drop plug in Fig. 4 as compared with the drop plug shown in Fig. 3.

Our experience satisfies us that our locomotive boilers have increased in size beyond the capacity of one or two plugs, as we have had cases where these large boilers can continue to be fired and the engine worked against the blowing of two drop plugs.

To overcome this it was necessary to equip large fireboxes with an increased number of drop plugs to obtain an effect similar to that of the sprinkler systems so successfully used in large buildings, which release a spray of water automatically in case of fire. Such an application of drop plugs is termed a multiple application. Fig. 5 shows a plan view of the crown sheet of a locomotive firebox with combustion chamber having 513 square feet of heating surface and a grate area of 139 square feet. The number of drop plugs, viz., six, is based on the application of one plug at the highest point of the crown sheet between the first and second rows of stays and one additional plug for each 400 square inches

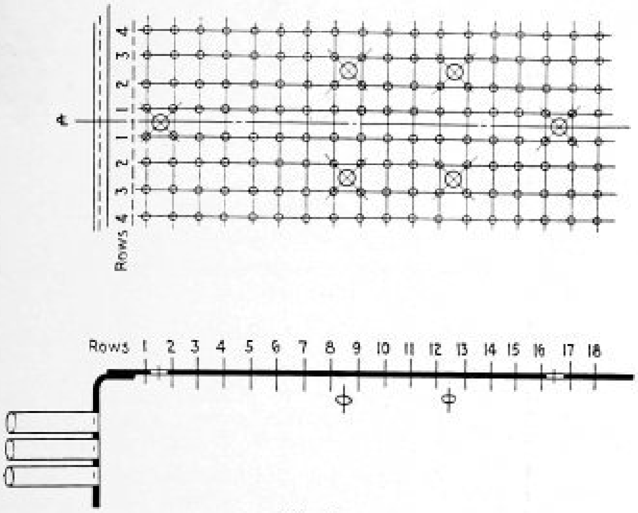


Fig. 5

of gas area of the flues, so located that the main group or the majority of these plugs are in the crown sheet directly over the hottest portion of the firebox.

Fig. 6 shows the inherent effect of the escape of steam through the drop plugs on the fire, preventing the rise of heat to the crown sheet.

Record of Drop Plug Applications

The table herewith constitutes a typical record covering the multiple application of boiler drop plugs since the year 1932 and up to and including August 19, 1935, the number fused on account of low water, and the number fused because of defects.

By referring to this record, it will be noted that during the year 1932, a total of 5138 drop plugs of the type shown in Fig. 4 in service on 1439 locomotives; in 1933 a total of 5205 drop plugs was in service on 1397 locomotives; in 1934 a total of 5204 drop plugs was in service on 1387 locomotives; and up to August 19, 1935, there were 5084 drop plugs in service on 1356 locomotives. Since reliable drop plugs can be manufactured, no inconvenience is being experienced with faulty or defective plugs, as the record shows that in 1932 there were only 2 drop plugs out of 5138 in service which fused where the evidence indicated low water but was not conclusive, and in 1933 only one plug out of 5205 in service fused where evidence was not conclusive that low water was the cause. In 1934 and 1935 we did not have a single plug fuse where the cause was undetermined. Therefore, the advancement of multiple applications of drop plugs to larger boilers has been accomplished with gratifying results, as will be noted from the information given in the following paragraphs.

I feel that the report on this important topic would not be complete if I did not quote herein official reports made covering the circumstances involved in a portion of the cases where plugs fused because of low water. Lack of space is the only reason why we have not included the entire number, but you have my assurance that those I have omitted are parallel in fact to those quoted below:

Engine 2266 failed on train No. 334 near Danebo on account of fusing of drop plugs in the firebox. Investigation developed the fact that water was allowed to become low in the boiler. Right and left back plugs fused. Lot No. 100 of fusible metal. No damage to firebox.

Engine 2663 dropped two plugs in the Los Angeles Yard. This engine is equipped with four plugs. Examined the boiler and found that water was allowed to get low enough to fuse the plugs, but not low enough to do any damage to the boiler. Water glass, spindles, and gage cocks were in perfect condition. Right injector worked perfectly. Left injector was inoperative. Although master mechanic reports that left injector was found to be inoperative on account of a defective intake valve, the fireman, in his statement, repeatedly brings out the fact that left injector was working satisfactorily all night and was, in his opinion, working all right at the time the drop plug functioned. No doubt, the injector failed previously to the engine losing water, the fireman thinking he had the injector on when it was not delivering water. Responsibility, however, is still that of the engineer and the fireman for failing to note that the injector was not delivering water.

Engine 1621, being used temporarily as a stationary boiler at Calexico, dropped the button of a fusible plug and was taken out of service. Could find no indication of the boiler being harmed. Water glass, spindles, gage cocks and blow-off found in good condition. Had engine fired up and both injectors worked perfectly. Water was allowed to get low enough to fuse plugs, but not low enough to harm boiler. This is a case where engine watchman permitted water to become low and upon discovering it put out the fire. Then, after the firebox had cooled down some, operated the injector and before getting the required amount of water in the boiler, as indicated by water glass and gage cocks, started a fire. He seems to have become excited when the stationary boiler was required to operate the fuel pump to supply oil to an incoming train and took a chance on getting up steam without the required amount of water in the boiler. Engine watchman accepts responsibility for failure to follow instructions in connection with firing up locomotives and maintaining proper water level in boiler while under fire.

Engine 2819 while being watched by engine watchman at Bowie failed because of drop plug fusing on account of low water for which the watchman was responsible. The back plug dropped bore the heat serial No. 51. Water glasses, gage cocks, water hose, strainers, connections, and injectors were found to be in good condition. No damage to the boiler.

Please be advised that two of the three drop plugs in the firebox of Engine 2926 at Tillamook fused on account of water being allowed to become low in the boiler. The front plug did not fuse. Investigation developed the fact that engine watchman went to sleep while in charge of the engine. Cost of repairs, $57.

Engine 2420 handling passenger train No. 56 between Delano and McFarland dropped two plugs due to low water. Testimony developed that shortly after leaving Delano the blow-off was used and the fireman started the feed-water pump and also put on the injector, but could not keep water in sight in the boiler. Train was stopped and fire put out. Crew found trouble due to operating handle of blow-off cock not being properly latched in forward notch of quadrant. When cock was closed the engineer tried the bottom gage cock and no water came from it, neither was there any water in the glass. Notwithstanding this he instructed the fireman to start the fire in the firebox. After starting the fire in the firebox, it was approximately 8 to 10 minutes before water appeared in sight and it was during this time that the two plugs dropped, preventing possible explosion and loss of life and property. The engineer was held responsible for failure properly to close the blow-off cock and for instructing his fireman to fire up the engine without proper water in sight in the glass and none in the bottom gage.

Engine 2510 on freight extra east at Toboggan dropped two plugs on account of low water in boiler. Investigation developed that water was rising in the boiler between Alamogordo Junction and Wooten. At Wooten, the engineer blew the boiler down good and at a distance of about 1½ miles from there found that he was unable to prime the right injector due to boiler check leaking slightly. Observation of water level at that time indicated to the engineer that there was sufficient water to permit pulling into Toboggan and shut off, which he did, in order to inspect the boiler check to determine and correct trouble. Between the time the stop was made and the time the engineer returned to the cab, the plugs dropped, preventing damage to the boiler. During the time the engine was losing water, it was operating under load on a 4.55 percent grade.

Engine 4360 in round house at El Paso had all five plugs drop due to low water. The hostler left the engine standing with a

Boiler Drop Plugs—Record of Application and Performance

(Pacific Lines)

Year	No. of Locomotives Equipped Each Combination 1	2	3	4	5	6	Total	Total Plugs In Use	No. of locomotives on which Plugs dropped because of low water Responsibility Crew	Yard or Roundh'se	Total	No. of Plugs Dropped Cause Undetermined No.	Percent of Total Plugs in Use
1932	85	109	493	455	246	51	1439[2]	5138	4	6	10	2[1]	0.0389
1933	..	109	516	472	249	51	1397[3]	5205	5	7	12	1[1]	0.0192
1934	..	97	501	489	249	51	1387[4]	5204	5	6	11	0	.....
1935	..	105	481	470	249	51	1356[5]	5084	7	5	12	0	.....

[1] Evidence indicated low water but was not conclusive.
[2] Does not include 172 locomotives out of service.
[3] Does not include 207 locomotives out of service.
[4] Does not include 98 locomotives out of service.
[5] Up to include 8-19-35 and does not include 74 locomotives out of service.

spot fire in the firebox, as he intended to move the engine to another stall later. A few minutes after leaving, a boiler washer connected the blow-down line to the engine and proceeded to blow it down for boiler washing. Inspection and test of the engine showed no damage to the firebox or boiler, and prompt functioning of plugs undoubtedly prevented a serious explosion.

Engine 4127 in round house at Roseville had one plug drop due to low water in the boiler. Investigation developed that the roundhouse foreman had checked the engine prior to the fire-lighter lighting the fire, and the gage cocks and water glass reflected that there was about 4 inches of water in the glass. The fire lighter lighted the fire one hour after the check was made by the roundhouse foreman and stated that there was 3½ inches of water in glass. He put some more water in the boiler and then left with a spot fire in the engine and neglected to watch the water level in the boiler. No damage was done to the firebox or boiler.

Engine 2510 on freight extra east at Toboggan had one plug drop due to low water while in charge of the engine crew ascending a 4.55 percent grade at four miles per hour on a 30-degree left curve. Investigation disclosed that water was becoming low in the boiler and that the fireman thought his injector was supplying water to the boiler. However, the overflow valve had become closed and was blowing back into the tank. At this time water became so low that 4 square feet of crown sheet surface became exposed and one plug fused. All appurtenances on the engine, such as water glasses, water column, gage cocks, etc., were tested and found free of any obstructions and in good working condition. No damage to firebox or boiler.

Engine 4337 standing in the round house at Imlay had one drop plug drop due to low water in the boiler. The engine had been put in the house with full pressure on the boiler and had been standing about ten hours when the drop plug fused. During this time no additional water had been put in the boiler. Inspection and test showed no damage to firebox or boiler.

Engine 4387 in Tucumcari round house had two drop plugs fuse and one start to fuse due to low water in the boiler. Investigation developed that the hostler opened the drain to the water glass and in some unexplained manner obtained the impression that there was 1½ inches of water in the glass. Fire was started and, upon going to the right side of the engine, the hostler observed the blow-down line connected to the blow-off cock. The fire was immediately extinguished. Between the time the fire was started and extinguished, about 3 minutes, the drop plugs fused. There was no damage to firebox or boiler.

Engine 4327 in Taylor round house had all five drop plugs fuse because of low water. Investigation developed that blow-off cocks either worked open or were kicked open so that water was allowed to get 3 inches below the highest point of the crown sheet while under the charge of the fire builder. The crown sheet was overheated covering an area of about 55 square feet. However, no serious damage had been done.

Engine 2554 fused one drop plug out of a total of four due to low water. Investigation developed that the engine was standing at Bisbee Junction awaiting completion of an air test, and while blowing out the boiler preparatory to leaving, the right blow-off cock stuck open. The injector was turned on and the crew attempted to reseat the valve in the blow-off cock. The other injector was put on and, as soon as it was apparent to the crew that repairs could not be made, the fire was put out. Shortly thereafter the plugs fused. It was found that the cause of the blow-off cock sticking open was because the ½-inch end of a ⅝-inch bolt had lodged under the valve, preventing it from closing. Inspection of boiler and firebox indicated that no damage had been done to firebox or boiler.

Engine 1834 on Extra East was backing up near El Centro at which time the two back plugs dropped. Testimony developed that while leaving Brawley, backing up, the engineer claims to have had lots of solid water in the boiler, and while going down grade the water was foaming badly. He eased off the throttle, cutting his speed to 25 or 30 miles per hour; opened the blow-off cock and blew down to about 3 inches of water in the glass. The blow-off cock was closed and as the engine was opened up again for a grade into Imperial, the engine foamed and the steam began to drop gradually to about 150 pounds pressure. The engineer heard something blowing in the firebox and when the train was stopped he discovered that two drop plugs had fused. Evidence showed that water was allowed to get about 3 inches below the highest point of the crown sheet or 6½ inches below sight

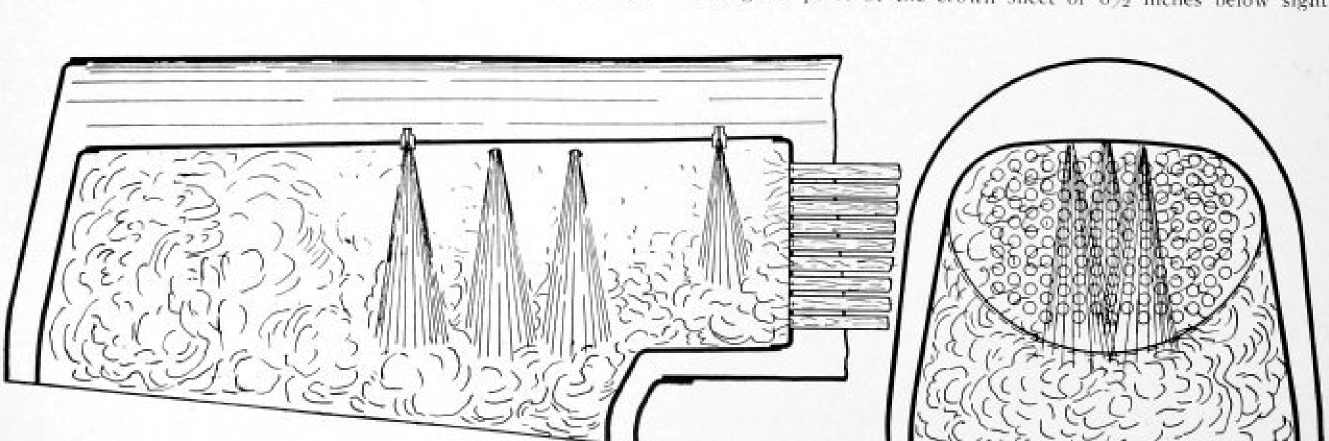


Fig. 6

in the glass, causing 220 crown stays and 25 of the top row of staybolts to leak slightly. The engineer had much experience in handling water in boilers in this territory and he stated that the injectors and feed-water heater were working satisfactorily. When the engine was stopped he opened the throttle wide to see if he could get water in the glass and then told the fireman to put the fire out. The engineer testified that he was satisfied low water was the cause of dropping the plugs and damaging the boiler. The fireman's testimony reveals that he was satisfied low water was the cause of the trouble and that he caused the damage to the firebox by forcing a heavy fire trying to build up steam pressure. At the time, in addition to the engineer and fireman, the head-end brakeman and conductor were also in the cab of this locomotive and their attention as well as the fireman's was called to the blow in the firebox. The multiple application of boiler drop plugs to this boiler unquestionably saved the lives or serious injury to these four men, in addition to damage and loss of property.

It is possible to imagine what the probable results would have been had these fireboxes not been equipped with a multiple application of drop plugs, not only in injury to crown sheets and company property, but possible injury and loss of life to passengers and crew.

When this type drop plug is manufactured, heat tests are conducted on one plug in each hundred. If that plug fails to meet the requirements then five more are selected at random. If any one of these five fails then the whole lot of 100 will be discarded. The requirements are that the button must not break loose at temperatures less than 550 degrees or more than 575 degrees F. These drop plugs actually fuse at a temperature of approximately 560 degrees. Considering the temperature of the water in the boiler at 200 pounds pressure to be 388 degrees F., it will be seen that due to a rise of but 172 degrees on the plug extension their prompt action to function is assured when plugs become bare of water and at a time considerably before the maximum temperature is reached that would affect the security of the crown stays. Laboratory tests have shown that stays pull through the crown sheet at temperatures between 1100 and 1400 degrees F. under a load equivalent to 200 pounds per square inch boiler pressure.

We, therefore, believe that the foregoing remarks incident to the multiple application of boiler drop plugs will impress those concerned with the fact that such an application increases the safety of operation. Further discussion will be confined to determine to what extent such applications will assist in reducing the cost of boiler maintenance.

The term "boiler maintenance," as referred to herein must not be taken to mean that expenses incident to the repair of staybolts, tubes, firebox sheet defects, etc., will be reduced because the boiler is equipped with a multiple application of drop plugs. However, we do believe that, when the crown sheet of a firebox in a locomotive type boiler is subjected to excessive heat due to water becoming low, much damage can be incurred. Repairs may be anything from the resetting of a few crown stays up to the renewal of the entire firebox. In many cases it may mean the general repair of the locomotive and possibly the tender.

Knowing that boiler explosions caused by crown sheet failures are the most prolific source of fatal accidents, explosions may be expected to increase in violence with the increasing size of locomotive boilers and the higher pressures carried therein. We have been told the most prolific source of casualties due to failure of fusion-welded seams has been in firebox crown sheets and that experience has shown these failures depend very largely upon whether or not the sheets or seams tear; that it is claimed riveted seams are superior in strength to welded seams under these conditions since the latter in some cases may be of unknown quality.

I believe that when the welding is done by competent operators, a welded seam in a locomotive firebox will give superior service to a riveted seam, and while it is known a welded seam can be made at reduced first cost and maintained at comparatively less cost than riveted firebox seams, I do not believe that a premium should be placed on welded seams by discriminating against their application to firebox sheets on locomotives with a multiple application of drop plugs.

It has often been asked, how does the boiler drop plug compare with the low water alarms? The boiler drop plug and the low water alarm serve two entirely different purposes.

The low water alarm is a device which gives an audible signal to warn the crew that the water in the boiler is becoming dangerously low. This enables the crew to take proper steps to correct this condition. It does not prevent an explosion if the crew does not take such steps upon the sounding of the whistle.

The boiler drop plug gives no warning, but in case of low water, fuses and either puts out the fire or causes sufficient disturbance in the firebox to indicate that something is wrong. It keeps the fire away from the crown sheet preventing its overheating, thus forestalling a boiler explosion. It eliminates the possibility of failure due to the human element, and is an added safety feature for the protection of an investment representing the value of an engine. Most important of all it safeguards human lives.

Recently a boiler explosion was experienced on one of the well known railroads of this country in which the boiler was equipped with a low-water alarm. According to the Interstate Commerce Commission accident investigation report, concerning this explosion, the whistle of the low-water alarm was blowing for several miles, but the engine crew took action too late. The result was a wrecked engine and the loss of three lives.

The use of boiler drop plugs on this engine would have prevented the accident, as the fire and crown sheet would have been affected by the fusing of these plugs as soon as the water became too low in the boiler.

My conclusion is that when the crown sheet is equipped with a multiple application of reliable drop plugs, so located and spaced that in the event the water in the boiler becomes low from any cause and before the crown sheet becomes overheated, these drop plugs will fuse and admit steam to the firebox in sufficient volume so the crown sheet will be protected, the procedure to allow welded seams in applying patches or new sheets or portions thereof is desirable economy and should not be discriminated against.

Discussion

O. H. Kurlfinke (Southern Pacific): I have been delegated to prepare a paper under the heading of a Special Report covering Boiler Drop Plugs. Before starting to read the paper I wish to make a few remarks in connection with it.

You have all heard Mr. Hall discuss fundamentals of the law establishing the Bureau of Locomotive Inspection,—safety is the first consideration. Around that word we work. Regardless of how well we might do a job, there is always the possibility of a failure, the human element. After the boiler makers have turned the engine over for service, something can happen that will result in injury or loss of life to some persons.

In connection with the fusible plug which we have used in principle to change the construction to make them more positive in action, I want to quote here with a few words to indicate our contention to the few people who have the subjects mixed. We contend two things: (1) Safety first and (2) that you can do a welded job on your locomotive fireboxes any place in the crown sheet if you have the proper protection.

In that respect we come to reducing costs in the maintenance of our locomotive boilers. That is why we weld them. We would not think of going back to the riveted seams if it can be avoided.

We have very few coal burners on our road. In an oil-burning furnace, which we have on our locomotives, the temperatures can be forced to the limit. You can burn them up. Therefore it is necessary that you have the proper protection.

A letter reached us which read, in part, as follows:

"The railroads are endeavoring to reduce maintenance and operating costs, and I do not believe the fusible plug will meet either of these two conditions; they will probably have to be renewed frequently to be assured of their condition and then if one should respond to a condition of low water, it means tying up the locomotive and the train as well as both train and engine crews until additional power can be obtained to move the train to destination."

In that gentleman's mind the possibility of engine failure exists. In the office of the general superintendent of motive power the topic of engine failure is a very important factor. Train delays are caused by various operating conditions but when it comes to a failure of a locomotive boiler the operating department puts it up to the mechanical department. We do not ever hear of many instances where we have train delays because of failure in the operating end of the job. The result is that the mechanical men get the idea, if they have a failure brought about by the fusing of a plug, that they won't use the plug, losing sight of the safety factor.

Recently, in connection with welded seams, there came to my attention a statement contained in the I. C. C. report of an investigation covering a recent boiler explosion. I would like to quote you from that statement:

"All the seams in the firebox were riveted except the half side sheet seams on the right and left side and the one-quarter door sheet seam, which was fused and welded.

"The crown sheet pulled down 55 stays; the threads on the bolts and in the sheets were in good condition except as damaged by the accident. The left side sheet failed along the welded seam from the inside throat sheet between the 16th and 17th longitudinal rows of stays. The door sheet welded seam one-quarter sheet failed from the door sheet-side sheet connection. The welded door sheet, fire sheet seams and left back corner of the firebox failed from the ring to the patch line.

"The side sheet welded seam failed for nine inches ahead of the throat sheet-side sheet seam. The right side of the combustion chamber sheet tore from the first transverse row of stays at the front in an irregular line to the second transverse row of stays through the 15th longitudinal row into the riveted combustion chamber throat sheet seam for a distance of nine inches, then into an irregular line down to a point nine inches back of the seam."

The inference back of that, my friends, would seem to be that the riveted seam stayed intact. I am giving you this quotation to show how the report contains evidence of welded seams that fail. There is no doubt about that but I do not want any restrictions on them because, as I mentioned before, you can have a first-class welded job but if the water gets low in the boiler there is reference made to the welded seam that failed.

C. A. Seley (Locomotive Firebox Company): I am not speaking for the Locomotive Firebox Company but as a member of the association.

Early in the 1900's while I was on the Rock Island Road, I was chairman of a committee of railroad officers created to set forth the boiler inspection rules brought about by legislation. We discussed the matter of these plugs for locomotive boilers as regards the rules. There was very little evidence of their value and use on railroads. The principal argument brought up in their favor was their use at that time in marine service.

I am not speaking for the motive power department of the railroads; neither am I questioning the value of the work which has been done on the Southern Pacific as brought out by this report. I am merely giving you the historical situation as regards the case and the reasons why we did not include fusible plugs among the rules,—due to a lack of information as to their general value and use on railroads and the probability of difficulty,—at least at that time,—of getting the care needed for their performance because they simply will not work after you put them in after a certain time has elapsed.

Those things have been worked out and I understand there have been improvements made which have contributed to the present status as shown in the report.

J. A. Doarnberger (Norfolk & Western): The fusible plug is nothing new to any of us. We remember that in our infancy we had fusible plugs. Of course they were made up of all kinds of compositions such as lead, tin, pewter, copper, etc. Speaking for the Norfolk & Western Railroad, we use low water alarms. We do not wait until the firebox gets down to its vital point, but have the alarm set for 4 inches above the crown sheet. I daresay we have not called in a Federal inspector in the last fourteen years to examine or look into an accident with a low water condition.

C. W. Buffington (Chesapeake & Ohio): Fusible plugs are of very little value on large engines with combustion chambers.

Lewis Nicholas (The Monon Route): There is no question that the fusible plug is one of our oldest means of safety, and any means that is adopted to insure safety is worth the expense. I have no quarrel with the Southern Pacific's application of multiple plugs. It is merely a matter of what the railroads want to adopt, whether you want to go to the multiple fusible plug, whether you want to go to a practical low water alarm or whether you want to go to something on the order of the thermic syphons. They are all good and worth what they cost.

Fusion Welding

(*Continued from page 280*)

perience that by running them in service maybe six or eight months, then welding them, we overcome this trouble.

C. W. Buffington (Chesapeake & Ohio): I agree with Mr. Doarnberger in regard to welding seams. I believe this should be investigated as a possible remedy for the cracking in riveted seams. I wish to commend the course taken by the Federal Inspection Bureau, but think the time has now arrived for a wider use of the welding processes. Personally, I think this should be a separate department, something similar to the practice of The Baldwin Locomotive Works.

Sigurd Christopherson (New Haven): We used to do as Mr. Doarnberger. We have fireboxes acetylene welded in 1914 that are still running. We use the oxy-acetylene process on the New Haven. I would like to find out if the Master Boiler Makers' Association adopted the electric arc as their standard. We are still building our fireboxes, our syphons, and everything else in the firebox except the flues with the gas process and we have very good success.

President Fogerty: I would like to answer that question as president of this association. We have adopted no standard, either electric-arc or oxy-acetylene, as far as welding is concerned.

Modern Power — Nickel Plate 2-8-4 locomotive

Method of preventing

STAYBOLT LEAKAGE AND CRACKING OF FIREBOX SHEETS

Committee

M. V. Milton

C. W. Buffington

J. J. Powers

Your committee in the study of the question of staybolt leakage and firebox sheet cracks finds them so closely interrelated that it is rather a difficult problem to establish which is the primary cause. However, experience and lengthy observation have led us to the conclusion that under some given conditions leaky staybolts are the primary cause of firebox sheet cracks, while it is also true from other causes checks and cracks develop first and lead to leaky staybolts.

Needless to say there is no sovereign remedy for the prevention of these conditions, but considerable improvement has been made in their prevention by the study of the causes and the application of appropriate remedies as far as possible. With this thought in mind your committee brings before you the following probable causes coupled with the necessary preventive methods.

Improper Materials. The materials out of which staybolts and firebox sheets are manufactured should meet a specification that will insure the best quality for the purpose, both from a chemical as well as a physical standard. Sheets should be of a quality that will meet rigid requirements.

Workmanship. Having obtained the correct material, the workmanship such as flanging and forming of fireboxes must be of the best and the same high grade of workmanship must apply in the application of the sheets and staybolts.

Improperly Fitted Staybolts. Bolts slack in holes, stripped threads, poor thread in holes, thread of bolts out of pitch, may be considered as improperly fitted.

An improperly applied staybolt can be made tight temporarily but will eventually give trouble. Every care should be exercised in the manufacture and application of staybolts, true to pitch and size. Taps should be watched for wear to ensure good thread in holes; bolts should be applied to a tight fit; a bolt that can be turned in position by hand should be rejected; all bolts should be hammer tested before cutting off surplus; any bolt not sounding solid should be rejected. Special care should be exercised in riveting. Good bolts can be spoiled by driving without adequate holding on. The best method is double gunning with combined holder on and riveter. Even though the blows may not synchronize, the air guns are held tight to the bolts by the holding on arrangements.

Bolts should be applied from the outside, thus insuring tight bolts and uniform length on the inside of the firebox and no distress to the inside sheet is caused by burning off the surplus ends of staybolts.

Distressed Area Ground Holes. Where holes are punched too large the area around the holes is strained beyond the point where such material may be removed by the reamer and tap. This is the beginning of cracks.

Holes in the firebox sheets should preferably be drilled. Where punching and reaming are resorted to, holes should be punched at least ¼ inch less in diameter than the required size.

Incrustation. The formation of scale on the waterside of sheets and staybolts makes it necessary for the sheet to be heated at a higher temperature to produce the steam required.

The main factor in the elimination of this trouble is the furnishing of proper water for locomotive boiler use. This involves close co-operation between the mechanical and the engineering departments. The best water available in the various districts should always be utilized and the unfit water avoided wherever possible. Where the natural water is not soft, water softening plants should be installed and the operation of these plants closely supervised by competent men. Where the expense of a water-softening plant is not justified, a treatment of known merit and composition should be used under direct supervision of men familiar with the chemical reactions of water in a locomotive boiler. Mechanical officers must interest themselves in knowing that the locomotives are being supplied with the best water available in the district.

On the Chicago and North Western Railway all mechanical officers such as master mechanics, road foreman of engines, and boiler inspectors, whose duties require their being on the road, are familiar with the testing of water and take a lively interest in the operation of the treating plants. At each opportunity they make tests and forward the results to the water supervisor. In many localities, the analysis of raw water changes rapidly and, therefore, requires a constant checking to know that the water delivered is properly treated.

On the Canadian National Railways water treatment is all internal. Each large terminal is equipped with testing sets and a record is kept at the terminal of tests made.

All boilers should be equipped with proper blow-off facilities, which should be so designed that engine crews will have no excuse for not using them.

The use of properly treated water will enable the operation of boilers indefinitely if the proper blow-off schedule is maintained. This will reduce considerably the strains set up in expansion and contraction of boiler sheets when the boilers are blown down frequently for washout. Therefore locomotive boilers should be operated as long as possible between washouts, consistent

Note: The committee which submitted this report is composed of the following members: M. V. Milton, chief boiler inspector, Canadian National Railways, chairman; C. W. Buffington, general master boiler maker, Chesapeake & Ohio Railroad; J. J. Powers, general system boiler maker, Chicago and North Western Railway Company.

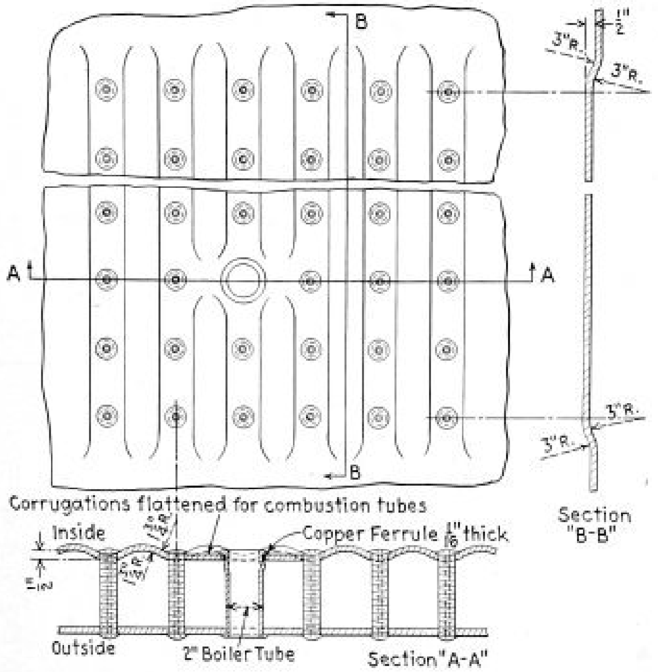


Fig. 1.—Corrugated side sheet practice of Chicago and North Western

with water conditions and governmental requirements.

Special Features. The Chicago and North Western Railway reports the use of corrugated side sheets which have been standard practice with them for some thirty years. These sheets have helped to eliminate staybolt leakage when the water conditions were unsatisfactory. They believe that the use of these sheets is a decided factor in the control and repair of small cracks which may develop after long periods of service. (Fig. 1.)

They have found that these cracks usually appear at the top of the corrugation, extending vertically. Cracks of this nature can be easily welded either by the oxy-acetylene or the electric arc process without removing the staybolts. It is, of course, necessary to be certain that the staybolts are in good condition.

Another advantage of the use of corrugated side sheets has been the elimination of grooving around the head of the staybolts on the fire side of the sheet. The main reason for this is the protection afforded the staybolt by the corrugation from the products of combustion of coal or oil, some of which are undoubtedly corrosive.

Their practice is to make up these corrugated sheets in their main shop, the corrugation being applied under hydraulic press, cold (Fig. 2). After the sheets are formed they are then annealed in an oil furnace.

The Canadian National Railway, which operates in severely cold districts, reports the use of an air deflector used in conjunction with the ash pan. This deflector is bolted to the bottom of the mud ring. Its function is to deflect the cold air from the side sheet to a point where it must pass through the fire. They also report a method of packing the space behind the side grate carrier bar, Fig. 3, with asbestos to eliminate the corrosion of the side sheet at the lower area caused by the products of combustion.

In conclusion your committee wishes to state that the principal points in the methods of prevention are good materials, good workmanship, and good water.

Details of Chicago and North Western Practice

In order that details of the Chicago and North Western practice may be more fully treated than was possible in the general report, abstracts from the individual report submitted to the chairman, by J. J. Powers appear below:

Speaking from my experience on the Chicago and North Western Railway, I can state briefly that we have had very little trouble from staybolt leakage, especially where we have our water conditions under complete control. It is true that fireboxes do develop cracks after long periods of service, but these cracks can usually be detected and repaired before any delay or failure occurs on the road. We have found that proper water treatment will postpone the development of these cracks indefinitely.

During the past fifteen years our boiler and firebox conditions have shown such a decided improvement that failures from this cause are very rare. When such a failure does occur, it is thoroughly investigated jointly by our mechanical forces and our Water Supply Department, and proper steps taken to prevent a recurrence. In former years, previous to our improvements in the water supplied to locomotives, it was necessary to renew fireboxes every twelve to eighteen months in some of our locomotive districts. Today, in these same districts, our boilers operate a minimum of five years and longer before slight cracks appear. The two main factors responsible for this improvement have been improved water conditions, and a better grade of firebox steel. It is my opinion that the mechanical department can practically eliminate trouble from this type of failure by working closely with the men in charge of the water treatment program of the railroads. The closer the co-operation the less chance of failure, as we have often found out in the past that properly treated water eliminated all trouble, which at times was very serious.

The use of corrugated side sheets has been a standard practice on the Chicago and North Western Railway for some thirty years. These sheets have helped to eliminate staybolt leakage when the water conditions were unsatisfactory. It is our opinion that the use of these sheets is a decided factor in the control and repair of small cracks which may develop after long periods of service.

We have found that these cracks usually appear at the top of the corrugation, extending vertically. Cracks of this nature can easily be welded with either gas or electricity without removing the staybolts. It is, of course, necessary to be certain that the staybolts are in good condition.

Another advantage of the use of corrugated side sheets has been the elimination of grooving around the head of the staybolts on the fire side of the sheet. The main reason for this is the protection afforded the staybolt by the corrugations from the products of combustion of coal or oil, some of which are undoubtedly corrosive.

Our practice is to make up these corrugated sheets in our main boiler shop, the corrugations being applied under hydraulic pressure cold. After the sheets are formed they are then annealed in an oil furnace.

The main factor in the elimination of this trouble is the furnishing of proper water for locomotive boiler use. On the Chicago and North Western Railway all mechanical officers such as Master Mechanics, Road Foremen of Engines, and Boiler Inspectors, whose duties require their being on the road, are familiar with the testing of water and take a lively interest in the operation of the treating plants.

All boilers should be equipped with proper blow-off facilities, which should be so designed that engine crews will have no excuse for not using them.

Locomotive boilers should be operated as long as possible between washouts, consistent with water conditions and government requirements. The use of properly treated water will enable the operation of boilers indefi-

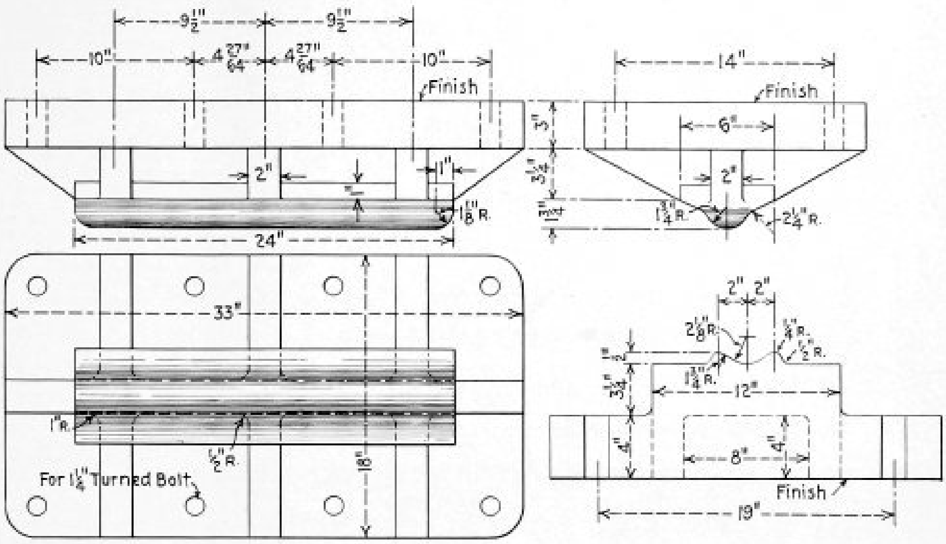


Fig. 2.—Dies used by the Chicago and North Western for forming corrugations in side sheets

nitely if the proper blow-off schedule is maintained. This will reduce considerably the strains set up in expansion and contraction of boiler sheets when the boilers are blown down frequently for washout. The hazard of carrying too high concentration can be readily eliminated by checking the boiler water at the terminals. *Systematic blowing off, both on the road and at the terminals, will promote the serviceability, which means less time in shops and engine houses.*

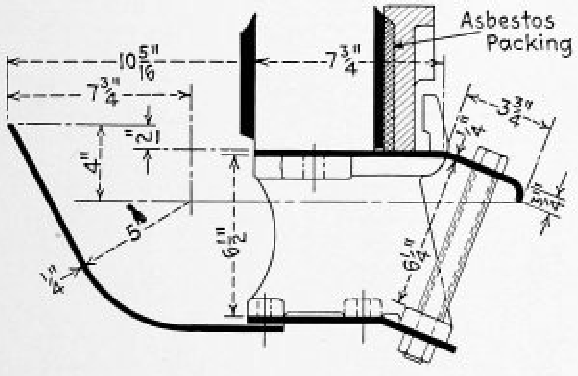


Fig. 3.—Asbestos packing behind side grate carrier bar

Anti-foam compound, when necessary, should be used only under rigid supervision to avoid serious trouble due to over-concentration of the compound.

Fireboxes should be inspected for leaks after every trip. Any indication of unusual leaking is sufficient cause to call on the water department.

The longer engine runs are also a help in the elimination of trouble from staybolt leakage and firebox cracking as, the less dumping of fires and cooling of sheets, the less the possibility of starting leakage, especially on power which has been out of the shop several years.

Where hot water washout plants are in service, a constant check should be made of the temperature of the washout water and fill-up water. This water for both purposes should be as hot as can be handled safely and even then it is much colder than the sheets and boiler metal to be washed.

The conditions which were prevalent on the railroads in the past with little or no water treatment other than a few cure-all compounds would not be tolerated today and fireboxes burning out every year or every two years would cause a complete upheaval by the management. The water engineers are at the beck and call of the mechanical department. It is their job to know that the water is the best available in the territory. It is the job of the mechanical men, especially those of the boiler department, to co-operate with the water engineers. Together, progress will continue to be made along the right lines of lower boiler maintenance.

The present railroad management is keenly interested in the reduction of all expenses and realizes that improved facilities for prolonging the life of boilers and fireboxes show a gratifying return on the investments. These could be summarized by saying that the best results in the elimination of the staybolt and firebox troubles will be obtained by softening the water used in the boilers; rigid adherence to specifications on material; proper design and good workmanship; hot water washout plants; and a friendly co-operation between all departments in keeping the boilers out of the shop in excellent condition, thus prolonging the life of the locomotive.

Discussion

C. W. Buffington (Chesapeake & Ohio): An illustration of automatic ash pan dampers which save fuel and fireboxes is shown herewith. A new design of flanged type staybolt hole is also shown. We have two engines on which this design has been used. Both of these engines have completed one-half their cycle of mileage, and the bolts in the flanged holes have never required repair until the engines are shopped for classified repairs.

Our standard practice in regard to care and upkeep of locomotives is as follows:

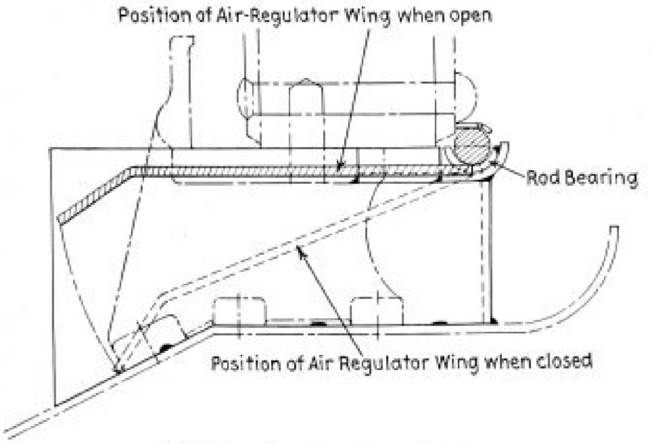
Care of Locomotive Boilers Including Method of Handling When Cleaning Fires, Washing Boilers, and Making Boiler Repairs

Scope.—This shop practice covers the method of handling all locomotive boilers when cleaning fires, washing boilers, and making boiler repairs, and should be followed on all classes of locomotives.

No deviation will be allowed from these rules except by written instructions from the superintendent of motive power.

The portion of this shop practice pertaining to filling the boilers and firing the engines also applies to engines which are in shops for classified repairs.

When to Wash Boilers.—All locomotives in service must have boilers washed at least once every thirty (30) days (or more frequently, if conditions require).



C. & O. automatic ash pan damper

Procedure at Inspection Pit.—When engine arrives at inspection pit, fire should be kept alive over the entire grate surface, especially along sides and flue sheets, to prevent air entering and chilling sheets. Fire should be maintained in this manner until arrival at cinder pit. Boilers should be filled with water until three gages of water is shown in water glass.

Procedure at Cinder Pit.—When engine arrives at cinder pit to have fire cleaned, fill boiler, then open ash pan slides and clean fire. Ash pan slides and fire door must be closed immediately after fire is cleaned. The blower must be used as gently as possible while engine is on cinder pit.

After fire is cleaned, the fire will be brought up to proper activity, with a live fire over entire grate area, then bed fire down level over the entire grate surface. After this is done bank coal around edges to prevent excess air from entering and chilling the throat sheet, side and door sheets around the mud ring. Fire must be maintained in this condition until engine is called for service. When engine is called for service, engine watchman must prepare fire for road service, in sufficient time, so there will be no delay.

Procedure When Necessary to Remove Fire.—When engine is at the cinder pit and it is found necessary to remove the fire from same for washing or any other cause, the ash pan must be cleaned after fire is removed, and engine taken into the roundhouse as quickly as possible.

The injector or feedwater pump must not be used after fire is removed.

After fire is removed at ash pit, the ash pan slides and fire door must be closed immediately.

The blower must be used as gently as possible while fire is being removed.

In cold weather the back cab curtain must be let down after fire is removed.

Procedure in Preparation of Washing Boiler.—Immediately after engine is put in roundhouse a cover should be placed over the stack and allowed to remain there at all times, except when necessary to use the blower, and blower should be used as little and as gently as possible. After covering the stack the blow-off cock should then be coupled to blow-off line in roundhouse and boiler pressure reduced 25 lbs., then close blow-off cock and allow engine to set 15 minutes to equalize temperature of sheets, repeating this procedure until pressure is reduced to 80 lbs., per square inch.

On H-7, H-7-A and T-1 locomotives the circulator should also be coupled to blow-off line in addition to coupling blow-off cock and circulator should be opened simultaneously with blow-off cock in making each reduction in pressure. This is to draw heat down in bottom of front end of boiler.

After pressure is reduced on boiler to 80 lbs., per square inch, one-half (½) hour's time should elapse between the time that the pressure is reduced to 80 lbs., and the time the blow-off cock is again opened to blow-off and drain boiler.

On H-7, H-7-A and T-1 engines the circulator should again be used in conjunction with the blow-off cock during this operation.

Blowing Off and Draining Boiler.—When one-half hour has elapsed after the pressure has been reduced to 80 lbs., the blow-off valve should be reopened and so regulated that it will take one (1) hour to completely relieve the pressure and drain the boiler.

The temperature of boiler sheets at this time should be approximately the same as that of the wash water. If superheater units are due for test and test is to be made on them by filling boiler, and if it is found that the temperature of the sheets is the same as that of the wash water, the boiler should be refilled with water and test applied to superheater units. If it is found the boiler has not cooled sufficiently, then it should be allowed to set until such time as the temperature of sheets is approximately that of the wash water before superheater test is made.

When the atmospheric temperature is 70° F. and above, the temperature of the washing water may be 100° F. When the atmospheric temperature is below 70° F., the same temperature of wash water must be used as that of the boiler plates and the temperature regulations should be made inside the roundhouse or shop where the water is used. Boiler washing plants should have thermostatic control to hold the water through the pump at 100° F. This should not be changed and the temperature control should be made at the boiler where the washing is done.

Washing Boiler.—When washing the boiler the work necessary on boiler and the washing should be handled as quickly as possible, and the following operations must be observed in order shown—

(A) Loosen washout plugs and remove top plugs at front end on top of boiler and plugs on top of boiler over combustion chamber. These plugs should be left out until the entire washing process is completed in order to let heat out of top of boiler and equalize temperature between top and bottom sheets. Do not remove other plugs.

(B) Clean syphons or arch tubes and do all necessary work possible in firebox while plugs are being loosened. When washing arch tubes and syphons they must be scraped clean with scrapers or pneumatic cleaners each time the boiler is washed. If scale is allowed to form in arch tubes or syphons the metal becomes overheated and bulges are formed, and if allowed to remain, they will cause tubes or syphons to warp out of line with connection to firebox, which will set up strains and cause cracking or bursting of the tube or syphon. Therefore, no locomotive should be allowed to leave a terminal with dirty arch tubes or syphons.

Note: The condition of these with regard to scale on the water side can be readily determined by the presence of clinkers adhering to the fire side. If an arch tube or syphon is clean on the water side it will be clean and smooth on the fire side. The condition of the firebox sheets can usually be determined by similar practice. It may be laid down as a general rule that clean fireboxes on the water side are clean and smooth on the fire side. Any clinkers adhering or sand paper roughness on the fire side indicates scale formation opposite.

(C) Plugs should then be removed over runboards, also those above firebox and on backhead of boiler. The boiler must then be washed over the top. Begin washing through holes on side of boiler opposite front end of crown sheet.

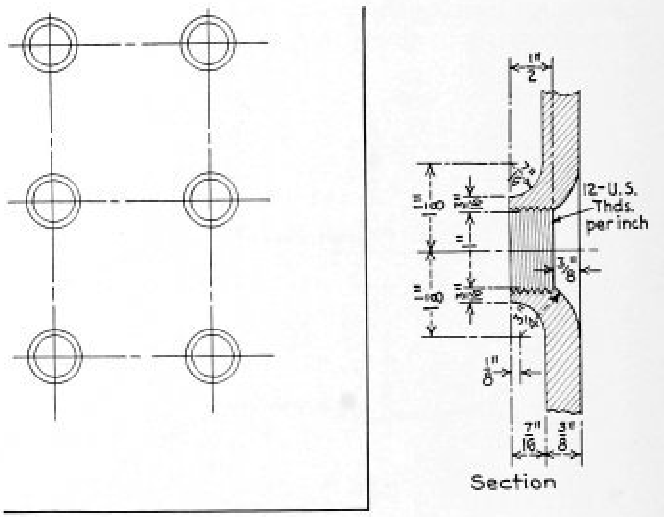
Note: Plugs mentioned not to be all removed at one time, but must be removed as washing proceeds from front to rear end, each plug to be replaced before proceeding to next location.

(D) Wash top of crown sheet at front end, then wash between rows of crown bars and bolts at right angles to nozzle directing the stream toward back end of crown sheet. After washing through holes near front end of crown sheet, use holes in their respective order toward the back of crown sheet, replacing plugs before moving to next location, as is done in barrel of boiler. The object of this method is to work the mud and scale from the crown sheet toward the side and back legs of the boiler and prevent it from depositing on the back ends of the flues. In order that washing water may be drained, open blow-off cocks when washing is started. While washing crown sheet from boiler head revolve nozzle so as to wash top of boiler and all radial stays or bolts as well as crown sheet. All scale must be removed from crown sheet; if necessary enter boiler or thump crown sheet with large size chipping hammer.

(E) Wash back end of flues through holes in connection sheet revolving nozzle so as to wash all foreign substance from back end of flues and flue sheet.

(F) Wash the water space between backhead and firebox door sheets through the holes in backhead, being careful to remove all scale and mud above and below fire door hole.

(G) Return to holes on side of boiler opposite crown sheet, using nozzles, revolving same so as to thoroughly wash down side sheets and staybolts, making sure that all spaces on side of firebox are clear of mud and scale. Then wash through holes near check valves near front end of boiler.



Flanged type staybolt hole

(H) After the above instructions have been complied with, remove and reapply plugs as it becomes necessary, washing the barrel of boiler, starting at front and working toward throat sheet, using the straight nozzle directly against the flues, reaching as great a space as possible in all directions, after which use the bent nozzle through the front hole in bottom of barrel and also straight nozzle in same manner as above until certain that the flues and spaces between the flues and barrel are as clean as it is possible to make them.

(I) After barrel of boiler has been washed, use nozzles in side and corner holes of water legs, revolving same thoroughly to clean the side sheets, and finally clean off all scale and mud from mud rings by means of straight nozzle in corner holes.

(J) Inspect boiler thoroughly. It must not be assumed that because clear water runs out of holes that the boiler is clean, but all spaces must be examined carefully with rod and light, if necessary, using pick, steel scraper or other tools to remove accumulated scale.

(K) Tighten all washout plugs.

(L) After all the boiler work is completed and the washout plugs tightened, the boiler should be filled, taking 45 minutes, minimum time for filling. All engines, except those equipped with type "E" superheaters, must be filled through the blow-off cock, and engines equipped with the type "E" superheaters must be filled through the branch pipe and throttle. The temperature of the water entering the boiler should be approximately the same as the boiler sheets when water is first started in the boiler, and should be gradually increased until the temperature of the water reaches that of the heating plant.

(M) On Class H-7, H-7-A and T-1 locomotives as soon as the filling water covers the top of the circulating nozzle the circulator should be turned on and left turned on for at least one hour after the fire is started in the locomotive.

(N) On all mallet, T-1 and B-1 engines that require heavy boiler work and on which the boiler has become cold, one hour should be taken for filling the boiler. On smaller classes of engines the boilers may be filled in a shorter period of time; however, in no case must any boiler be filled in less than a half hour. When starting to fill boilers that have become cold, the temperature of the water at first should correspond as closely as possible with that of the boiler plates and the temperature gradually increased so that at the end of an hour the water will be the same temperature as that of the filling system.

(O) The temperature of the washing and filling water should be noted at intervals.

Care Prior to Lighting Fire.—In all cases, except where engines are to be stored, immediately after washing boiler and completing boiler work in firebox, a 3-inch bed of coal must be placed on the grate to cut off any draft through the firebox. The fire door should then be closed and blower shut off and not reopened until necessary to light fire.

Firing Up Boiler.—After fire is started, the pressure should be raised as follows:

(A) For H-7, H-7-A and T-1 engines only:

1 hr. 30 mins.	50 lbs. max.
2 hrs. 30 mins.	150 lbs. max.
3 hrs.	Full pressure

(B) All engines, except H-7, H-7-A and T-1:

1 hr.	50 lbs. max.
1 hr. 30 mins.	100 lbs. max.
2 hrs.	150 lbs. max.
2 hrs. 30 mins.	Full pressure

Moving Cold Engines.—In cold weather when it is necessary to move a cold engine, the sheets should be warmed to take the chill out of the metal in the firebox. If a small fire is built to do this, be sure there is no coal on the grates and be certain it is put out after the chill is removed from the firebox sheets.

Working on a Cold Boiler.—Before working in the firebox or welding is done on any of the parts when engine is cold or when engine has been in roundhouse two or three days, two feet of cold water should first be run into boiler, then steam should be turned on and allowed to run into boiler through blow-off cock, increasing the volume of steam gradually until sheets are warm to the hand. Sheets should be kept warm in this manner until boiler work is completed.

Tightening Up Loose Plugs, Studs and Screwed Connections.—If leaks develop at any screwed connection into boiler, no attempt must be made to stop the leak by screwing in while boiler is under steam pressure.

Changing Water in Boiler.—It is frequently necessary, on account of foaming conditions or other causes, to change water in locomotive boilers. When making a water change, the boiler must be filled with water as nearly as possible of the same temperature as the boiler.

When water hose is used to wash out any part of boiler, it is considered a washout, and all plugs must be removed. See I. C. C. Rule 45—Interpretations.

Testing of Locomotive Boilers.—Every boiler, before being put in service and at least once after every twelve months service, shall be subjected to a hydrostatic pressure twenty-five percent above the working pressure. Boiler should be filled with water as nearly as possible of the same temperature as the boiler. Temperature of water, while test is applied, should not be lower than 90 degrees and not higher than 120 degrees. In cases where boilers are filled with cold water, (which should be done only when boiler is cold), the temperature should be raised to the above limits by using steam. While making the hydrostatic test, the pressure should fluctuate as little as possible.

Steam Test and Method of Applying Hydrated Lime.—Hydrated lime is only to be applied to boilers which have had flues removed and heavy repairs made. If not necessary to let water out of boiler to make repairs after hydrostatic test, let water out to desired amount to make steam test and apply as follows:

"Stir the hydrated lime in cold water. Remove plug from top of boiler and pour the mixture through a funnel into boiler. Amount of hydrated lime to use shown in table below; Paragraph No. 17."

TABLE SHOWING CLASS OF ENGINE AND AMOUNT OF HYDRATED LIME TO BE ADDED TO BOILERS

Class	Lbs.	Class	Lbs.	Class	Lbs.	Class	Lbs.
A-14	30	C-16	30	G- 6	30	H-7	60
A-15	30	E- 5	30	G- 7	30	H-7-A	60
A-16	30	F-11	30	G- 8	30	J-1	50
B- 1	50	F-12	30	G- 9	30	J-2	50
C- 2	30	F-13	30	G-11	30	K	50
C- 3	30	F-15	30	G-12	30	K-1	50
C- 6	30	F-16	30	G-15	30	K-2	50
C- 7	30	F-17	50	G-17	30	K-3	50
C-12	30	F-18	50	H- 2	60	K-3-A	50
C-14	30	F-19	50	H- 3	60	M-3	40
C-15	30	G- 3	40	H- 4	60	M-3-A	40
C-15-A	30	G- 4	40	H- 5	60	M-4	40
C- 5	30	G- 5	40	H- 6	60	M-4-A	40
						T-1	60

The boiler shall be fired up and the steam pressure raised to not less than the allowable working pressure and the boiler and appurtenances thoroughly examined. All cocks, valves, seams, bolts and rivets must be tight under this pressure and all defects disclosed must be repaired.

Washing Out Boiler.—The boiler before being put in service should then be blown down and allowed to cool. After boiler cools it should be thoroughly washed out to remove any sediment caused by the use of the hydrated lime.

Hydrated lime is placed in boiler to form a protective alkaline film on the metal surfaces retarding pitting and corrosion and to remove grease and oil from boiler.

Removal of Dome Cap.—The dome cap or inspection dome cap must be removed after making the hydrostatic tests, and the interior surface and connections of the boiler examined as thoroughly as conditions will permit.

The above instructions shall in no way conflict with the Interstate Commerce Commission's Laws, Rules and Instructions for the inspection and testing of Locomotives, Tenders and Their Appurtenances.

Hydrated Lime to Be Applied to Engines Laid Up.—To prevent any damage being done by corrosion while engines are laid up out of service at any point during winter months, the amount of hydrated lime shown for the respective classes of boilers in the table should be applied to the boilers through bottom washout plug holes in back head, syphoning the hydrated lime by the use of an air gun.

During summer months, engines laid up out of service will be filled with treated water, where available; and where treated water is not available, hydrated lime should be applied as above outlined.

When storing T-1 locomotives or other engines equipped with type "E" superheaters, see special instructions.

Shop Practice Governing the Blowing Down of Locomotives at Terminals and on Road

All locomotives having blow-off cocks in back mud ring corner with muffler attachment are included in this Shop Practice and should be handled accordingly.

ATTENTION AT TERMINALS

When engine arrives at terminal, fire should be put in good condition, boiler filled with water to top of water glass and injector shut-off. Blow-off cock in back mud ring corner should be opened wide and allowed to remain open until full glass of water has been discharged from boiler. If engine is equipped with blow-off cocks in both back mud ring corners, one-half a glass should be blown from one which would then be closed and the other half blown from the other. Care should be taken with regard to using blower with fire in bad condition.

When leaving terminal before engine is dispatched from ready track, fire should be put in good condition, the boiler again filled with water to top of glass, injector shut-off, and blow-off cock opened wide until full glass has been discharged from the boiler. If the boiler is equipped with blow-off cocks in both back mud ring corners, one-half glass should be blown from each side. Care should be taken with regard to using blower with fire in bad condition.

This terminal blowing will be performed by the shop forces.

ON LINE OF ROAD

Freight Engines.—On line of road engineer will blow boiler every nine or ten miles by opening the blow-off cock wide three times, holding it wide open for a few seconds each time. On long, heavy, adverse grades, where it is undesirable to blow boiler every nine or ten miles, engines may be run not to exceed twenty miles before being blown off.

Also, after engine has been at rest for a period of time, such as taking siding or making water stop, blow-off cock should be opened wide for period of not less than 10 seconds with injector shut-off, just before leaving point of stop.

In case of foaming trouble interfering with operation of locomotive, engineer will fill boiler with water to top of water glass, shut off injector, and open blow-off cock wide until glass of water is discharged. If trouble is especially bad, it may be necessary to repeat this operation in order to remove sufficient dirty water from the boiler and replace it with fresh water from the tank to insure good operation.

Passenger Engines.—Passenger engines will not be blown on line of road except when, in the judgment of the engineer, it is necessary to prevent foaming and delays to trains.

Switch Engines and Shifters.—Engines in switching and shifter service will be blown by engineer approximately every hour, at convenient time, by opening the blow-off cock wide open three times and holding it open for a few seconds each time.

In case of foaming interfering with operation of engine, boiler should be filled with water to top of glass, injector shut off, and blow-off cock opened wide until full glass has been discharged, in order to replace sufficient dirty water in the boiler with fresh water from the tank to relieve the trouble.

GENERAL

Do not fill the boiler or use injector while blow-off cocks are open.

In case of unusual water conditions which require special attention, the matter should be referred to Master Mechanic or General Master Mechanic, who will handle with the chemist, furnishing him necessary information for additional instructions.

G. E. STEVENS (Boston & Maine). We started in using corrugated side sheets about three to four years ago. At the last shopping of one engine the side sheet that was not corrugated had to be removed. The side sheet that had a corrugation in it had a split at the bottom near the mud ring that had been electrically welded, about 6 inches long. We removed this about 10 inches above the weld and applied a new bottom section. The engine is still in service.

At the present time, where we apply side sheets on our high-pressure boilers we have adopted this as a standard practice. Our corrugations run about 36 inches high. I notice from the report that the staybolts are applied between the corrugations, which I approve. Our staybolts are in the corrugations, which I claim limits the expansion and contraction of the corrugation.

J. W. KELLY (National Tube Company): I claim to be the father of the corrugation on the Northwestern. When I came from Albany, Mr. Quayle told me that there were some engines running in Iowa in which the side sheets lasted only six or seven months. When these engines came to the Chicago shops, we got the side sheets out, full size. They were cracked in places 16 to 18 inches long from the staybolts up. We turned them over and there was hard scale, as hard as flint; you could hardly chisel it out.

I said to the superintendent of motive power, Robert Quayle, "If fire and water will corrugate a side sheet like that, why not let us corrugate them first just like that and see what will happen. Let us take the strain away from the staybolt and place it some place else in the corrugation and see if the corrugation will take care of the expansion and contraction. Then let us try to get better water, so as to get away from that hard scale."

Robert Quayle said, "Go ahead. Try six of them. Send them out."

We did so. After those engines had run a year or two years the staybolts did not leak. All the master mechanics who got those six engines commenced to demand "Corrugated side sheets." Mr. Quayle said we would try twelve more. We had the same results.

Those side sheets were put in about thirty or thirty-two years ago. I have been away from the Northwestern twenty-four years. They have had lots of changes there and apparently have come back again to this practice.

G. E. Stevens: We do not claim that the elimination of staybolt leakage is all due to our corrugation. We started the corrugated side sheets about the same time we started using compound. Both have helped eliminate staybolt leakage.

H. L. Miller (Republic Steel Corporation): The suggestions that have been made with regard to corrugations and depressions around staybolt holes are mechanical methods of trying to eliminate a condition which is due to the unequal heat through the thickness of the metal in the side sheet and also to a hot zone in the center of the side sheet.

The company with which I am connected decided that there might be a material that could be used in side sheets that would eliminate this difficulty for another reason; in other words, if we could apply a steel of lower thermal expansion so that we would have less expansion in the metal for the same amount of heat, we might not have the stresses that are set up around the staybolt holes.

The following report covers details regarding the application and service to date of a standard steel firebox made of this steel:

This report covers details regarding the application and service to date of a stainless steel firebox with two Nicholson syphons, which are at present in operation on the Wheeling & Lake Erie Railroad in locomotive 5125 used in switching service at Canton and Brewster, O. This locomotive is an 0-8-0 type switcher, built to the standard U.S.R.A. specification in the railway shop at Brewster, O. This locomotive was placed in service in September, 1930, and has been in practically continuous operation since that date, with the exception of two periods in the shop for flue removal. The water used in this boiler has 18 to 26 grains of hardness per gallon, mostly calcium carbonate with a small amount of magnesium sulphate. For the first three years in service, no treatment was used in this water. During the last two years, a small amount of soda ash has been used in the tender.

This steel is a product containing 18 percent of chromium and the principal characteristics and reason for this application is its low coefficient of thermal expansion. The value for this steel when heated to 920 degrees F. is 10.6 as compared with a value of 14.3 for regular firebox steel. This is approximately 30 percent less expansion for the same amount of heat. The firebox was completely welded throughout, using a coated rod of approximately the same analysis. The flues were rolled into the tube sheet without ferrules and turned over about 45 degrees before welding to the tube sheet. A plain carbon wire of the shielded-arc type was used in welding the flues. The flues were ordinary carbon steel analysis. Staybolts were of the hollow iron type from the mud ring to the radials. The locomotive was examined at washout periods for approximately seven days in service for over a year's time and the notation was made that the boiler scale falls off freely from the water side of the sheet when washing out this boiler. This is due to the steel shrinking less than the scale when cooling from service temperature to the washout temperature.

After two years of service a V of flues below the superheater types to the number of 150 were removed for scaling. From 1 inch to 1¼ inches of boiler scale was found on these flues.

At the end of the regular four-year period all the flues were removed and the firebox plates inspected. No evidence of corrosion was found on the firebox plate or tube sheet and the entire surface of the firebox was practically free from scale on the water side. The syphon bottoms were also completely clean and have remained so during the entire period of service without resorting to rapping during washout periods. The service life to date of approximately five years has shown no trouble of any kind nor any leakage of the arch tubes where they are rolled into the stainless steel sheet. The arch tubes require turbining at every washout, as they are made of ordinary steel and would quickly swell and burst if scale is allowed to accumulate in the hot zone.

It was thought that a low expansion type of steel placed in hard water conditions where heavy scale is encountered, might show a longer service life than the ordinary firebox steel. We all realize that the effect of scale is to increase the temperature of side sheets and cause higher expansion, which is the reason for cracking around staybolt holes.

Regular life of side sheets in engines of the same class in this district is about five years, so from this time on—the service of this firebox in its initial condition will be extra and above that obtained with ordinary steel in the same service.

H. H. Service (Santa Fe): The report suggests that bolts should be applied from the outside, this insuring tight bolts. I would like to know if there is anyone here applying staybolts from the firebox side and, if so, if any detrimental results have been found?

M. V. Milton (Canadian National): It is common practice to apply bolts from the outside. There are times that some have to be applied from the inside.

H. H. Service: We followed the practice of cutting off surplus ends with the torch for many years until the time came along when we adopted what was known as a staybolt nipper, turning the end of the bolt so it could be easily knocked off. We have a machine to drill a tell-tale hole deep enough so that when bolts are driven after application, the end of the bolt can be opened up very readily without consuming a lot of time in drilling. In order to avoid taking down pipe work, running boards and so on, we apply bolts from the inside.

We have tried to find some way of determining whether or not the practice is detrimental. In the last five or six years the life of our fireboxes has increased at least three years, with 100,000 more miles per firebox renewal, and we have had a great reduction in the number of side sheets applied.

I do not say we have eliminated all the trouble. We do have some leaky bolts. The side sheets to which I refer are applied in the same shops, by the same men, with the same staybolts; the same methods are used and in one district the bolts will give us no trouble and in another district we do have trouble with staybolts.

Another point I wish to bring out is that where we have leaky side sheets we have cracking at the staybolt hole. The bolts start leaking first and the crack develops afterward. There is hardly any scale on the water side of the plates. There are some small fillets in conjunction with the sheet—not anywhere near as bad as we have in some other territories where the bolts do not leak.

Edward J. Reardon (Locomotive Firebox Company): Side sheets leak. I do not know whether it ever occurred to you that underneath a stoker-fired engine they increase the heat in the fireboxes 800 or 900 degrees, but they never increase the water space. The trouble with the side sheets today, in my opinion, is that there is not water space enough with the stoker-fired engine and steel arch.

Mr. Manya on the L. & N. has what is called an offset patch and it has increased the life of the side sheets 30 to 50 percent. The reason is because they have about 8 inches of water. Pay a lot of attention to more water space. If you do not have it, you will always have trouble with side sheets.

Mr. Manya (L. & N.): A few years ago our road placed some Mountain type locomotives in service. Within less than a year's time we experienced considerable trouble with leaky staybolts and cracked side sheets. This trouble was so extensive that a great many of our master mechanics felt it would be only a short time until we would have to buy new fireboxes. After conferences with the superintendent of machinery, master mechanics and others I was authorized to apply the water space patch referred to by Mr. Reardon.

We made the patch with a dish 2½ inches deep, dished inward. The dish extended longitudinally about one-half the length of the entire side sheet. It was applied to three of our Mountain type engines in the shop for heavy boiler repairs. Not until the fourth year was it necessary to do repair work on them. Some of those sheets have run as long as five years, whereas before, one year was all we could get out of the straight side sheet. The total water space with the dished patch amounted to 7 inches.

G. E. Stevens (Boston & Maine): I cannot quite agree with Mr. Reardon on the wider water space. We took one of the engines that was giving us a lot of trouble and we increased our water space at the foundation ring 2 inches and maintained the 2 inches to within about 12 inches of the crown sheet, and that engine after being in service a short time gave us just as much trouble as the one with the 6-inch water space.

J. A. Doarnberger (Norfolk & Western): This to me is quite an interesting subject. We all know what leaky staybolts are, but did it ever occur to you, outside of the improvement that has been made on flexible staybolts in the breaking zone of a boiler, that we are today applying staybolts just the same as we were fifty years ago? The only thing is that we've got motors to help us out in driving the taps faster and running the bolts in the taps, and a little improvement in the nipper—pneumatic nippers—and we are burning them off now with acetylene. But that hasn't corrected our troubles at all.

In 1926 we built ten Mountain type engines carrying 220 pounds

(Continued on page 297)

Application and maintenance of

ARCH AND WATER TUBES

Committee

W. N. Moore

C. A. Harper

R. A. Pearson

Your committee finds that the application of arch and water tubes to a boiler, especially to that of the locomotive to be of vital importance. Therefore, great care in their maintenance is most necessary and should receive the utmost consideration in order to get full returns from them in service.

Your committee finds the individual reports as submitted by the committee members to be of such importance that we consider it of far more benefit to submit the reports in this manner to the convention for their consideration and discussion.

Report of the Chairman W. N. Moore

Arch tubes serve a very definite and important purpose in the locomotive firebox, therefore their preparation and application should receive the most careful supervision, to see that the material as it comes from the manufacturer is up to specification, as to grain, gage and uniformity.

Tubes may be bent hot or cold and, where an acute bend is required, the tube must be worked hot. After all bends have been made, the tube should be gaged with a moon or half-moon gage to assure that it is as nearly a perfect round as possible.

Templates for all classes of engines should be kept on hand on the arch tube racks. To insure that tubes are bent uniformly by fitting the template to firebox holes, the actual length may be taken and marked on the tube. Tubes may be tried also in holes and marked at the inside of each sheet, this however consumes more time. After numbering the tubes, they are to be delivered to the power saw machine to be cut to length, then annealed, and delivered back to the firebox for application. A standard spacing gage should be used in relation with other tubes in the firebox, according to the firebox layout, Fig. 1. Tubes should be set 3/8-inch in the water space, rolled and beaded to 1/16-inch of the sheet. Care should be taken in setting rolls so that they extend well beyond the inside of the firebox (Fig. 3).

Tubes should be cleaned with a rotary cleaner before the boiler inspector makes his inspection of the entire application. As soon as the inspector is satisfied that the proper application has been made, he is required to make out an "Arch Tube Certificate," (sample form indicated) showing the engine number, date, location of the tube in the firebox, and cause for its removal. This certificate to be signed by the boiler maker applying it and by the boiler inspector, in duplicate; one copy to be sent to the chief boiler inspector and one filed in the local office. Standard practice should prevail throughout the application on the railroad involved.

Maintaining arch tubes after they are properly applied is a matter of keeping them clean. To this end a careful eye should be kept on the cleaners to see that

Note:—The committee which submitted this report is composed of the following members: W. N. Moore, general foreman boiler maker, Pere Marquette Railway, chairman; C. A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis Railway; R. A. Pearson, general boiler inspector, Canadian Pacific Railway.

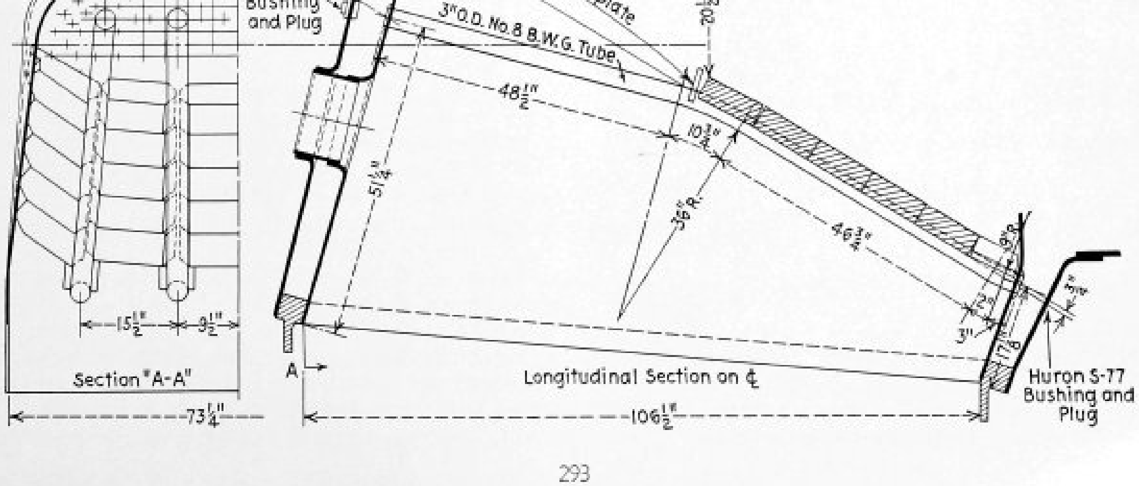


Fig. 1.—Standard spacing gage should be used for arrangement of arch tubes

cutting cones are in reasonably sharp condition and in good working order; that the internal cleaner to be used as a reamer is applied, and that the boiler washer does not wiggle his cleaner up and down in the tube, but feeds

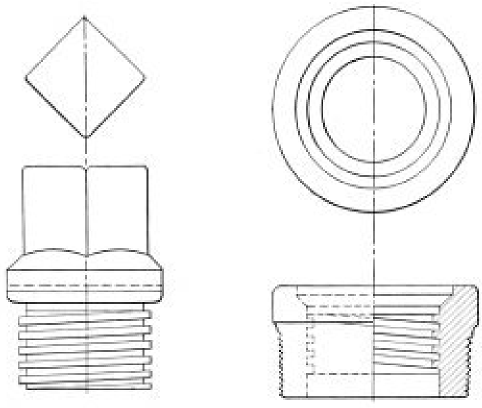
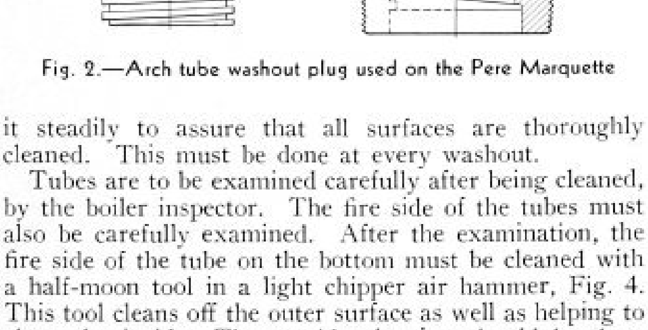


Fig. 2.—Arch tube washout plug used on the Pere Marquette

it steadily to assure that all surfaces are thoroughly cleaned. This must be done at every washout.

Tubes are to be examined carefully after being cleaned, by the boiler inspector. The fire side of the tubes must also be carefully examined. After the examination, the fire side of the tube on the bottom must be cleaned with a half-moon tool in a light chipper air hammer, Fig. 4. This tool cleans off the outer surface as well as helping to clean the inside. The outside cleaning should be done prior to turbining. By use of this half-moon tool our railroad was able in 1925 to reduce arch-tube renewals from 35 tubes per month in the Wyoming roundhouse to less than 1 per month. Where we were renewing tubes on account of blisters, buckling and other causes on the bottom side of the tubes, we are now wearing out arch tubes on top from brick movement which takes anywhere from two years to four years to accomplish. The real secret to arch-tube life is to keep them clean inside



D	C	B	A	Line
No. 8-B.W.G.	$3\frac{5}{32}$"	$3\frac{1}{32}$"	3"	1
No. 8-B.W.G.	$3\frac{21}{32}$"	$3\frac{17}{32}$"	$3\frac{1}{2}$"	2

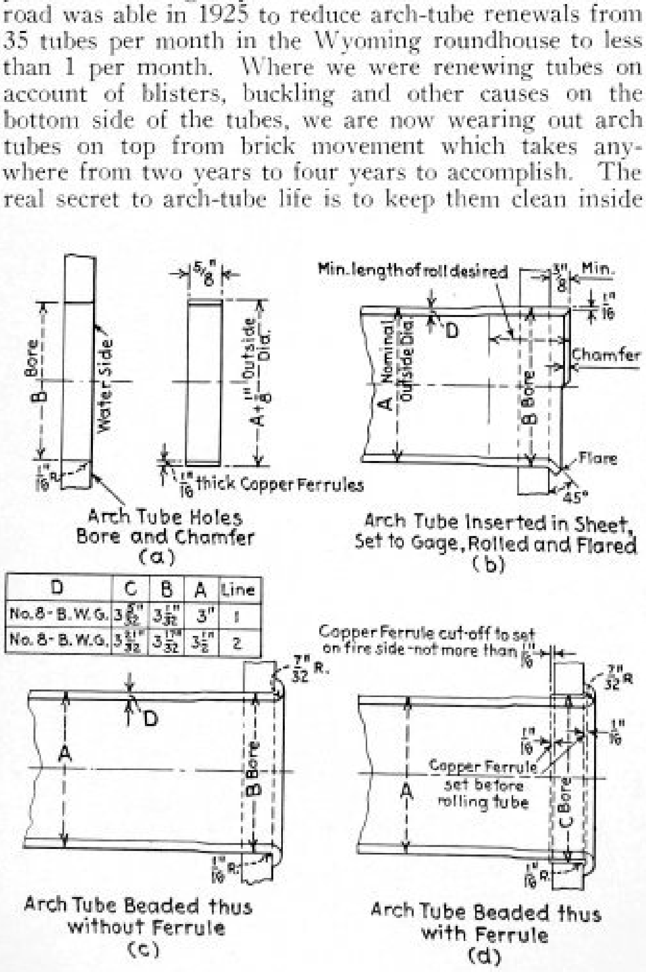


Fig. 3.—Steps in the application of arch tubes

Arch Tube Certificate

Place ____________________

Date ____________________

This is to certify that I have this date applied__________
Location

Arch Tubes to engine______and that same was properly prepared,
number

set, rolled and beaded.

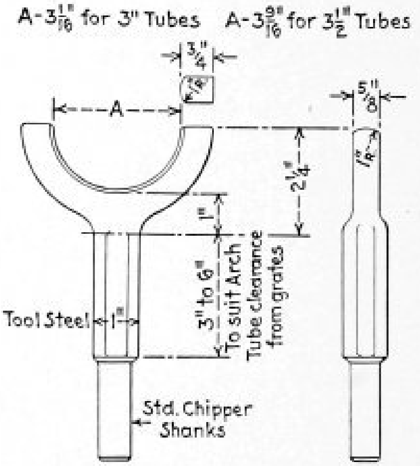
Signed____________________
Boiler Maker

This is to certify that I have personally examined Arch Tube mentioned above, both inside and outside and find above report to be correct.

Signed____________________
Boiler Inspector

Cause for removal____________________

This report to be made in duplicate, one copy to be held by local Boiler Inspector, and the other to be forwarded to Chief Boiler Inspector.



Use on bottom side of arch tubes on every wash-out preferably before turbining. Used on P.M. 10 year's practically eliminating arch tube trouble.

Above tool may be enlarged to suit Thermic Syphons. Make "A" $7\frac{1}{8}$" and all other dimensions accordingly - Shank may be made for long stroke if desired

Fig. 4.—Half-moon tool for cleaning arch tubes

and out. They will give full term of service and finally wear out where they should, on the top side next to the arch brick.

C. A. Harper Report

Application of Arch Tubes. Arch tubes should be bent at the shops, but in an emergency the engine house can do the bending, using an old tube as a template. They should be applied at right angles to the sheets.

Determine the length of the tube by actual measurement of the firebox, allowing ⅜ inch to ½ inch for projection into the water space at each end; then bend to a template conforming to the instruction drawing and cut to proper length.

Tubes shall be securely fastened and flared with a seven-roller flaring expander.

No oil is to be used in applying the tubes.

When the tubes are applied, stamp the abbreviation of the shop or engine house and date applied on the underside of the tube approximately 9 inches from the door sheet, using ¼-inch figures and standard abbreviations.

Record all inspections, repairs and renewals in the record book.

When the arch tubes are found to be too short, the tubes should be carefully removed in order not to destroy the evidence, and held for inspection of the supervisor of boilers. A report should be made of such cases to the supervisor of boilers, showing when and where applied.

Copper Ferrule Applications. Copper ferrules are to be used in the firebox sheets for all arch tubes. If the holes are larger than standard size, extra gage ferrules must be used to compensate for the increased size of the holes. Arch tube ferrules should be set with 1/8-inch projection on the fire side of the sheet and secured in place with the roller expanders.

Copper Ferrules Used in Application of Arch Tubes

Outside diameter of arch tube, inches	Diameter of holes in sheet, inches	Ferrules: Outside diameter, inches	Ferrules: Gage B.W.G.	Ferrules: Gage Inches	Ferrules: Length, inches	Where used	When used
3	3 5/32	3 5/32	15	0.072	3/4	Front and rear sheets	New work
3	3 3/16	3 3/16	14	0.083	3/4	Front and rear sheets	Maintenance
3	3 13/64	3 13/64	13	0.095	3/4	Front and rear sheets	Maintenance
3	3 15/64	3 15/64	12	0.109	3/4	Front and rear sheets	Maintenance
3 1/2	3 21/32	3 21/32	15	0.072	3/4	Front and rear sheets	New work
3 1/2	3 11/16	3 11/16	14	0.083	3/4	Front and rear sheets	Maintenance
3 1/2	3 45/64	3 45/64	13	0.095	3/4	Front and rear sheets	Maintenance
3 1/2	3 47/64	3 47/64	12	0.109	3/4	Front and rear sheets	Maintenance

Inside and outside edges of all arch tube holes must be slightly rounded to remove sharp edges on new work.

Arch Tube Cleaners—Maintenance and Use. Arch tube cleaners, when not in use, should be kept completely submerged in a bath of kerosene oil.

Each time before using cleaners, the kerosene oil should be blown out, after which the cleaner should be thoroughly lubricated with good grade of light machine oil, such lubricating process to take place before each cleaning of a set of arch tubes.

Care should be taken so that the hose will not come in contact with the oil as oil materially affects its life.

Before using the cleaner, a careful examination should be made of the cutters and other parts to know that they are in good working order.

To prevent the cleaner from entering the water space at the lower end, which would be liable to cause damage to the cleaner, a stop should be applied to the front end of the arch tube before inserting the cleaner in the tube. A supply of cutters, pins and drill heads should be kept on hand at each engine house so that these parts can be renewed without any unnecessary delay.

A sufficient number of extra air-driven arch-tube cleaners should be kept in stock at the principal storerooms so that, when a cleaner is sent from the engine house to the shops for repairs, it can be replaced at once in order that the arch tubes may be properly cleaned.

When the cleaners fail to work properly (except when in need of minor repairs, such as new cutters, pins or drill head) the engine house forces should not attempt to make repairs, but should send the cleaner to the shop for the necessary repairs.

To insure proper cleaning of the arch tubes, the cleaner should be worked slowly back and forth until the workman is satisfied that all the scale has been removed from the tube.

Inspection of Arch Tubes When Boiler is Washed. Clean off the exterior and examine the arch tube for bulges, warping, brick wear, cracks next to sheet, leaks at setting or ferrules working. Clean the interior with a pneumatic tube cleaner; examine with a light to see if the ends of the tubes are of proper length, properly flared and free from scale or other foreign substances; tighten leaking arch tubes with the roller expander. When the arch tubes are found too short the tubes should be carefully removed so as not to destroy the evidence and held for inspection of the supervisor of boilers or his representatives, making report of such cases to the supervisor of boilers showing when and where applied.

In addition to the above practices, all the arch tubes formed at the shops are turbined before bending to remove the mill scale. After the tubes are bent a ball gage 1/16-inch less than diameter (inside) of the tube is passed through to insure roundness of the tubes at the bends, then the tubes are again turbined to remove the scale formed by heating.

The Big Four follows the practice of beading the ends of the arch tubes (after the tubes are set with the flaring rollers). After beading, the ends of the tubes are given a re-rolling with the straight hand rollers.

R. A. Pearson Report

Standard practice on the Canadian Pacific Railway for the application and maintenence of arch and water tubes is as follows:

All arch tube holes must be carefully located in accordance with application drawings. In no case must the bridges between the edges of the tube and the staybolt holes be less than 1 inch in width. All sharp edges on holes in inside sheets must be removed by rounding slightly with a reamer or file. Tube holes in the back tube and door sheets should be drilled 3 1/32 inches for 3-inch arch tubes and 3 17/32 inches for 3 1/2-inch tubes. Plug holes in the throat and back head sheets must be drilled 3 1/8 inches for 3-inch and 3 1/2-inch tubes, Fig. 5. Tap out the holes in the throat and back head sheets with a 1-inch 8-taper tap, 11 Whitworth threads per inch to suit 3 1/8-inch bronze washout plugs.

For fireboxes equipped with sleeves, as in Fig. 6, use a plug with square threads as shown. This latter ar-

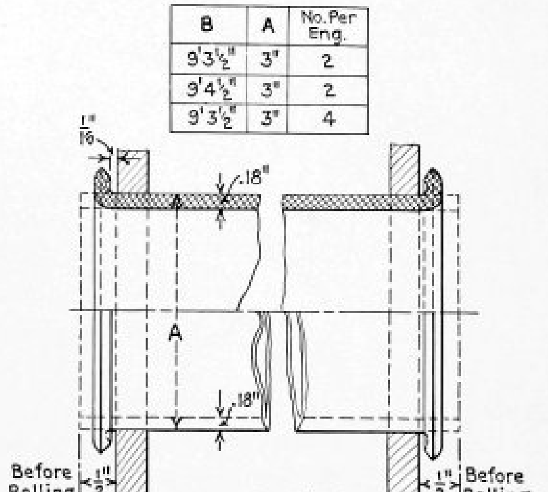


Fig. 5.—Application of arch tubes

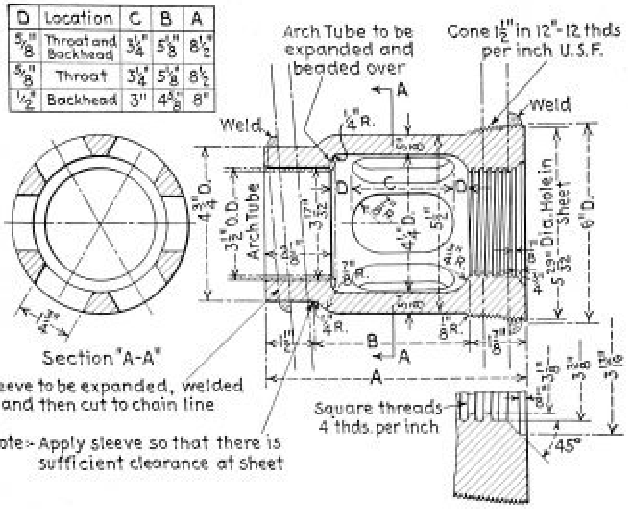


Fig. 6.—Plug with square threads

rangement is used on locomotives carrying working pressures of 250 pounds per square inch and over, and is very satisfactory. The sleeve arrangement is also shown in Fig. 6.

Only tubes that conform to Canadian Pacific Railway Specifications should be used as arch tubes. These are seamless steel 3 inches or 3½ inches outside diameter and 0.165 inch or No. 8 B.W.G. thick.

Tubes should first be bent to templates which conform to dimensions on the application drawings, Fig. 7, care being taken to avoid flattening at the bends, as this prevents proper maintenance and may obstruct the rotary cleaner.

To allow for variations in individual fireboxes, the correct length to which the tubes must be cut should be measured by putting the tubes in place in the firebox. The allowance for beading should be ½ inch at both ends, measured from the water side of the sheets. After cutting to length, the ends should be annealed and the tubes inserted in position in the firebox. The template for correct spacing, as illustrated on the application drawing, should then be put in place, as shown, and the tubes rolled, flared and beaded. The bead when turned over should not bear against the sheet, but should stand clear $1/16$ inch as shown in Fig. 5.

Maintenance. All arch tubes should be inspected after each trip. Leaky tubes must be tightened by rolling, the ends of the tubes being first cleaned of scale. At each washout they must be well cleaned, using a standard rotary cleaner, care being taken not to push the cleaner beyond the end of the tube, or damage to the cleaner may result. After cleaning, the tubes must be thoroughly inspected and their alinement checked by placing over the tubes a wooden template made in accordance with the dimensions shown on the application drawings. Arch tubes must not be welded or safe ended. The rollers used are standard makes for applying arch tubes, and beading tools are made suitable for this work.

The mechanical officer in charge at the point where the tests are made is held responsible for the safe condition of the tubes that are returned to service with any defects. Whenever making any tests covered by Canadian Pacific Railway Regulations, as well as Canadian Board of Railway Commissioners Rules, such as the monthly service test, quarterly shop test, and annual hydrostatic test, firebricks must be removed from the arch tubes and the tubes carefully inspected for defects, such as blisters, pitting, warping, cracking or any other defect which may weaken the tube. Tubes badly warped or defective in any other way must be removed. Slightly warped tubes may be straightened with a tool designed for that purpose. When the boiler is empty at tests, the arch tubes must be hammer tested for thin spots. At each washout and particularly at the monthly boiler tests, both ends of the arch tubes should be inspected to make sure that the tubes are properly flared and beaded.

Ordering. The number, length, diameter and thickness of the tubes for various classes of locomotives are stated on a Canadian Pacific Railway regulation card covering this subject.

Fig. 7—Arch tube application and instructions for using template

Staybolt Leakage

(*Continued from page 292*)

per square inch pressure. During these ten years these engines have made approximately 6,500,000 miles. They average about 55,000 to 60,000 miles a month on a long run, and during the ten years with about 6,500,000 miles eleven staybolts in the ten engines have been broken.

Now when it comes down to a wide water space to correct staybolt leaking on the side sheet, there is nothing in that. We have a 7-inch water space in most all of our big engines. We built, about five years ago, twenty Mallet engines carrying 300 pounds pressure. We have experienced considerable trouble with the bolts leaking along the fire line above the grates, about eight or nine rows above the mud ring, the full length of the firebox. We renewed them so frequently that the holes got large and, of course, we were blamed for putting in loose bolts.

So when we got to an engine to repair with a pretty good pair of side sheets, we made some experiments. The first thing we did, we picked out four master taps; put them on the master gage; and we tapped out the nine rows of bolts above the mud ring and put in a straight threaded tap and a straight bolt. We did the same thing fifty years ago.

We tightened up all the bolts throughout the boiler and cut off the nine rows above the mud ring, but did not drive them. We knew we had the very best fit that could be made except with a tapered tap. When this was done, we applied pressure to these boilers and they commenced to leak. The more the pressure arose, the more they leaked. They leaked until we got around 300 pounds pressure; when we got to 375 pounds we could not get near the boiler because of the bolts leaking. Mind you they were a good fit. After we got done, we drove the bolts up. Naturally they were tighter. They stood all the tests.

We got together and turned out a lot of plates about 6 or 8 inches square and we tapped them and screwed the bolts in under proper application. Then we got out six more plates and we screwed the bolts in them and we headed them over the same as you'd drive them in the boiler,—hit them full in the face, swell them out, turn them over. We have heard that all our lives.

When we got this done we ground the heads off, didn't chip them or anything but ground them off flush with the plates. I think that bolt started out under 186 pounds on the testing machine. That is all it took to back it out after it was driven. Then we split them; took them to the laboratory and had them tested. We actually had not swelled them out over a thread or a thread and a half. That is all we got, and we proved it by microscopic tests and by etched tests. Just as soon as the pressure comes on the boiler and breaks the thread or thread and a half, the result is a leaky boiler.

There is nothing original, as my friend said, about it. But in February of 1934 one of these boilers came in. I went down and looked at it and it had pretty large holes in it, carrying 300 pounds pressure. It was a shame to cut the side sheets out to reduce the holes, to get a smaller bolt in, so I conceived the idea that we would put a tapered hammered head bolt in there the same as we put in the crown sheet. We had the bolts made, twelve and a half threads and tapered. We nicked the heads and screwed those bolts in there about two and a half to three threads and burned off the heads. We held them on and did the outside job first, drove the bolt up on the outside sheet and cupped it. Then we just worked the edge over to keep it from impinging on the end of that bolt. I want to tell you gentlemen that was February the 8th a year ago and we haven't touched a bolt in that boiler since. We have twenty-five or thirty engines and are building some new ones now, and eight to nine rows above the mud ring and the full length of the boiler we are going to put tapered hammered head bolts and depend on the taper to keep them tight.

Registration at Master Boiler Makers' Business Meeting

Aiken, C. H., boiler equipment department, Republic Steel Corporation, 18403 Winslow Road, Cleveland, O.
Allison, L. D., locomotive inspector, Bureau of Locomotive Inspection, I. C. C., 46 Post Office Building, Columbus, O.

Beck, John F., retired boiler foreman, G. R. & I. R. R., 426 Thomas Street, S. E., Grand Rapids, Mich.
Bell, H. A., general boiler inspector, Chicago, Burlington & Quincy R. R., 2647 S. 13th Street, Lincoln, Neb.
Buffington, C. W., general master boiler maker, Chesapeake & Ohio R. R., 50 Marne Drive, Huntington, W. Va.
Burkholtz, G. E., traveling general boiler inspector, St. Louis & San Francisco R. R., 1019 State Street, Springfield, Mo.

Callahan, J. L., general boiler inspector, Chicago North Western R. R., Oelwein, Ia.
Christopherson, Sigurd, supervisor, boiler inspection and maintenance, New York, New Haven & Hartford R. R. Company, 17 Sheldon Street, Milton, Mass.
Cook, E. C., managing editor, *Railway Journal*, 120 La Salle Street, Chicago, Ill.

Doarnberger, J. A., general master boiler maker, Norfolk & Western R. R., 1502 Patterson Avenue, S. W., Roanoke, Va.

Fogerty, Kearn E., general boiler inspector, Chicago, Burlington & Quincy, 61 S. Lincoln Avenue, Aurora, Ill.
Foss, M. A., boiler service engineer, Locomotive Firebox Company, 310 S. Michigan Avenue, Chicago, Ill.
France, Myron C., general boiler inspector, C., St. P., Minneapolis & Omaha Ry., 512 Drake Street, St. Paul, Minn.

George, William, boiler foreman, Jackson Shops, Michigan Central R. R., 1111 E. Ganson Street, Jackson, Mich.

Hagan, G. N., supervisor of boilers, Erie Railroad, 1048 Liberty Street, Meadville, Pa.
Hancken, W. C., boiler foreman, Atlanta, Birmingham & Coast Ry., 802 S. Grant Street, Fitzgerald, Ga.
Harper, Carl C., general boiler inspector, Chicago, Cleveland, Cincinnati & St. Louis R. R., 814 Big Four Building, Indianapolis, Ind.
Hasse, Frank C., general manager, Oxweld Railroad Service Company, 230 N. Michigan Avenue, Chicago, Ill.
Hedeman, Walter R., assistant mechanical engineer, Baltimore & Ohio R. R., 3315 Echodale Avenue, Baltimore, Md.
Heidel, Edward H., general boiler foreman, Chicago, Milwaukee & St. Paul R. R., Milwaukee, Wis.

Kahn, Julius A., general boiler foreman, Elgin, Joliet & Eastern R. R., 808 Sterling Avenue, Joliet, Ill.
Keiler, W. H., locomotive inspector, Bureau of Locomotive Inspection, I. C. C., 303 Federal Building, Omaha, Neb.
Kelly, J. W., boiler tube expert, National Tube Company, 515 North Grove Avenue, Oak Park, Ill.
Kilcoyne, Thomas F., arch brick engineer, American Arch Company, 2273 Washington Avenue, Norwood, Cincinnati, O.
Klein, Charles J., locomotive inspector, Bureau of Locomotive Inspection, I. C. C., 330 New Scotland Avenue, Albany, N. Y.
Klink, Charles M., general boiler foreman, Chicago, Milwaukee & St. Paul R. R., 3425 Longfellow Avenue, Minneapolis, Minn.
Koenig, Joseph, boiler foreman, Texas Pacific, Missouri Pacific, 317 Bermuda Street, New Orleans, La.—Terminal R. R.
Kurlfinke, O. H., boiler engineer, Southern Pacific Company, San Francisco, Cal.

Lacerda, Harry, boiler maker, Delaware & Hudson R. R., P. O. Box 81, Watervliet, N. Y.
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Boiler Maker and Plate Fabricator

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Business Manager of Boiler Maker and Plate Fabricator

George Slate

George Slate

Born September 27, 1874. Died September 26, 1935. Served for thirty-four years as business manager of Marine Engineering as well as of The Boiler Maker

George Slate, vice-president and a director of the Simmons-Boardman Publishing Company, New York, and widely known throughout the business paper publishing field, died at Overlook Hospital, Summit, N. J., September 26, at the age of 61 years.

For many years Mr. Slate has been intimately connected with, and has been widely known throughout, the boiler industry in his capacity as business manager of BOILER MAKER AND PLATE FABRICATOR. He has been active in the counsels of the Associated Business Papers, Inc., New York, since 1916, and has been highly respected by publishers everywhere for his ability in its work as a member and for some years as a director of that organization. His interest in fostering sound practices in publishing extended to the business paper division of the Audit Bureau of Circulations, in the activities of which he was prominent.

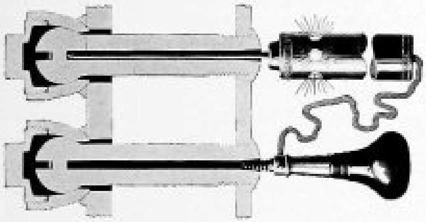
Mr. Slate was born on September 27, 1874, at Oxford, Mich. He was educated in the public schools of Alma and Grand Rapids, Mich., and started his business career in the classified advertising department of the Philadelphia Press, later joining the staff of the New York Journal in a similar capacity. His association with MARINE ENGINEERING AND SHIPPING AGE dates back 34 years, having joined the staff of that publication as an advertising salesman on October 14, 1901. He was later elected a vice-president of the Aldrich Publishing Company, which at that time published this periodical. That company in 1905 acquired THE BOILER MAKER and Mr. Slate's jurisdiction was extended to include that journal as well. In 1920 the Aldrich Publishing Company was acquired by the Simmons-Boardman Publishing Company and shortly thereafter Mr. Slate was elected a director of the latter company, on which board he has since served continuously.

He was an associate member of The Society of Naval Architects and Marine Engineers, New York. For fifteen years he served as secretary and treasurer of the Boiler Makers' Supply Men's Association and was greatly interested in the affairs of that organization, which recently has become a part of the Allied Railway Supply Association. Mr. Slate was a member of the board of governors of the Railroad-Machinery Club of New York and of the Canoe Brook Country Club of Summit, N. J.; a member of Overlook Lodge No. 163, F. & A. M. of Summit; a life member of Palestine Commandery No. 18, Knights Templars, New York, and a member of Salaam Temple, Shriners of Newark. He is survived by his wife, Mrs. Maude Slate, and a daughter, Mrs. Margaret Evans.

EQUIPMENT SECTION

Flannery Electric Contact Method for Inspecting Staybolts

The electrical contact method for testing flexible staybolts, developed by the Flannery Bolt Company, Pittsburgh, Pa., and now widely used on the railroads of the United States requires no change in the standard parts of a flexible staybolt assemblage, with the exception of providing a bolt with a tell-tale hole extending from the inner end into, but not through, the head of the bolt.



Flannery staybolt tester

These holes are protected from becoming closed by rust or corrosion by copper plating, and a fireproof porous plug is inserted in the inner end of the tell-tale hole to exclude foreign matter and permit leakage of steam or water if the bolt is broken or fractured.

Inspection is accomplished by establishing electrical contact at the extreme end of the tell-tale hole in the head of the bolt, by means of a device consisting of a light, batteries, and indicating rod, and connection to the boiler. The apparatus is simple and compact, and requires no particular care except the occasional renewal of a dry cell battery.

Reference to the illustration shown herewith will indicate the method of using the tester.

The Flannery method of detecting broken and fractured bolts has been built upon the fact that a broken bolt, having a tell-tale hole, will show leakage of water or steam, provided, the tell-tale hole is open or clear, and that it extends to every breakable portion of the bolt.

The Flannery tester is so designed and constructed that it will positively indicate whether or not the tell-tale holes are open for their entire length. If the bolt is broken or fractured into the tell-tale hole, leakage will positively occur.

The electric contact method completes an inspection quicker and cheaper than the caps alone can be removed and replaced under the cap removal method of inspection. The time required for the balance of the stripping represents the waste of that much money.

Two locomotives of exactly the same class, having exactly the same number of flexible bolts, were placed in the shop side by side. One boiler was equipped with solid flexible bolts, the other with Flannery tell-tale bolts.

The boiler equipped with solid flexible bolts, inspected in accordance with cap removal method, cost $183.85 under close official supervision. The boiler equipped with Flannery tell-tale bolts, inspected by the electric contact method, cost $18.95. In addition to the saving of 90 percent in inspection costs, the length of time required to make the inspection was cut to one-third of that ordinarily required—thus a direct saving of 66 percent in lost engine service was effected. These cost comparisons were taken in a modern shop equipped with crane facilities and improved methods for handling the work.

The function of the full length tell-tale hole in the Flannery tell-tale bolt is to serve as a constant watchman of the condition of the bolt—ever present to permit easy leakage and thus quick detection, should the bolt break, or be fractured, in service. The bolt cannot break with the boiler under pressure, without telling of this condition.

Electrunite Boiler Tubes Have Received Wide Acceptance

Since electric resistance welded boiler tubes were first introduced to the industry under the trade name, Electrunite boiler tube, by Steel and Tubes, Inc., Cleveland, they have been accepted or approved by many societies as well as government and municipal departments. The tubes were first accepted by the A.S.M.E. Boiler Code Committee in March, 1932 (Case No. 709) followed soon after by approval by the Bureau of Navigation and Steamboat Inspection and the American Bureau of Shipping.

During 1934 Federal Specification WW-T-731a, which is a revision of WW-T-731, was prepared by the Bureau of Standards to include electric resistance welded tubing. Many states and city departments also revised specifications to include this product.

During the current year Lloyd's Register of Shipping made an investigation of the product and approved it for use in vessels classed with that bureau. The amended Rules Nos. 1 and 2 of the General Rules and Regulations of the Bureau of Navigation and Steamboat Inspection Service issued as of January 1, 1935, have mentioned electric resistance welded tubing, stating under Rule No. 2, Section 13, Page 83,—"Seamless or electric resistance butt welded tubes shall be used in all construction where the tubes are subject to internal pressure." The bureau also approved the use of Toncan Iron electric welded tubing during the current year.

The A.S.T.M. has had under consideration for several years the adoption of a specification on electric resistance welded tubing and a tentative specification has been adopted by that Society this year. The tentative specification is an entirely separate specification from the existing specification A-83-34 written for seamless and lap welded tubing.

The Navy Department, Bureau of Yards and Docks, has just issued Specification 44-T-11A, which is a revision of 44-T-11. The new specification is patterned after Specification WW-T-731a which includes electric resistance welded tubing. It is interesting to note that the physical tests in both of these revised specifications require that the electric resistance welded tubes be subjected to the same tests as the seamless tubing.

Since the introduction of Electrunite tubing by Steel and Tubes, Inc., Cleveland, millions of feet of this tubing have been installed in all types of watertube and fire tube boilers, locomotives, stationary and marine, both for replacement and new boiler work. Some of the recent larger installations of new boilers in which Electrunite tubes are used are the 450 pound pressure sectional header boilers and water walls installed at the Evansville Plant of the Southern Indiana Gas and Electric Company; Chevrolet Motor Company Assembly Plant at Baltimore, Md.; the International Harvester Company, McCormick Works in Chicago; the Crystal Tissue Company Plant at North Excello, O.; the Gardner Richardson Company Plant at Middletown, O.; waste heat boilers at the Ford Motor Company Plant in Detroit and many others.

For replacement work large stocks of Electrunite boiler tubes are carried in most principal cities.

True Tolerance Rivets Increase Life of Locomotive Boilers

About seven years ago, one of the larger Class I railroads constructed four locomotive boilers, using Victor True Tolerance rivets made by The Champion Rivet Company, Cleveland. In a recent interview with the master boiler maker foreman of this road, he advised that these boilers had remained in service twice as long as the equivalent type of boiler fitted with ordinary rivets, and furthermore the riveted joints were still in good condition.

Victor True Tolerance rivets are very close to full size and they are cold rolled so as to render them absolutely round. They are made from the very best forging quality of steel and carefully sorted so as to insure the user getting the very best obtainable in rivets. Due to their close tolerances it is possible for the user to ream his holes 1/32 inch oversize, which further tends to produce a tight joint.

One or two bad rivets in a boiler are just like a bad apple in a barrel. They eventually all become bad and that is why we emphasize the use of good rivets in good plate construction.

The Ingersoll-Rand Pott Impact Wrench

Imagine a small machine weighing about 20 pounds that will spin down a 1-inch or larger nut at 700 revolutions per minute, and then give it a series of smart torsional blows at the rate of 1400 a minute to tighten it as securely as desired. That is just what this newest, and most remarkable of all pneumatic tools does.

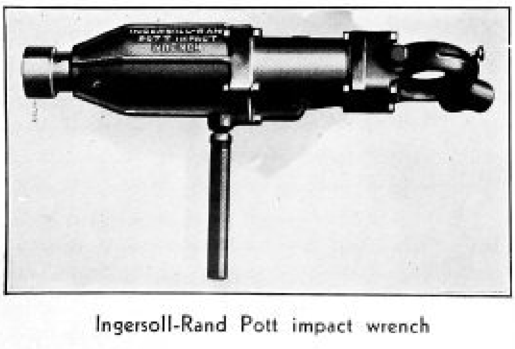
In the Ingersoll-Rand Pott Impact Wrench a principle entirely new to the pneumatic tool field is brought into play—that of the rubber "accumulator." This is a cylindrical block of special rubber interposed between the multi-vane air motor and the chuck. In operation, the torque from the motor is applied to the accumulator which, in twisting, becomes shortened, lifting the hammer from engagement with the anvil. The hammer is then released and is spun forward to the next engagement, thus delivering a powerful blow, with considerable mass behind it, to the anvil, on the end of which the chuck is attached.

These torsional impacts occurring at the rate of 1200 to 1400 blows a minute exert a more powerful turning effect than is possible with any other portable wrench. This type of turning action, new to a power wrench, makes it possible to remove nuts which could not be taken off except by splitting with a chisel or burning with a torch.

One man operates this wrench with ease. The accumulator absorbs the torque and eliminates the danger of shock or injury to the operator. The cushioned action makes it possible to operate the impact wrench on high places or in positions that would be unsafe with any other type of machine.

It would be unwise to attempt to predict the limitless number of uses to which this new tool will be put or the fields it will enter. Certainly there is need for a tool of this nature in railroad shops, refineries, shipbuilding, structural steel shops and field jobs, automotive and other manufacturing plants, and in fact, wherever considerable nut running, whether applying or removing operations are to be done.

For additional information concerning the Ingersoll-Rand Pott Impact Wrench, address Ingersoll-Rand Company, 11 Broadway, New York City, and ask for descriptive pamphlet No. 2152.



Ingersoll-Rand Pott impact wrench

Apexior Surfacing Materials for Interior of Locomotive Boilers and Tender Tanks

Apexior Number 1 is a brush-applied surfacing material for the water side of flues, shells, firebox sheets and staybolts. The main field of service is the interior of boiler equipment at any temperature and pressure. The Apexior protects against corrosion by filling and covering the surface of the metal to an average thickness not over 0.003 inch. Water contact and penetration is prevented. The character

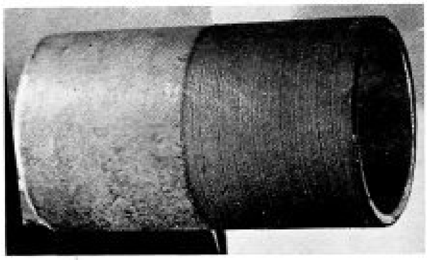


Fig. 1.—Section of standard locomotive flue — half bare and half surfaced with Apexior number 1

of the Apexiorized surface is such that dirt and scale do not bond as tightly as to bare steel. Boiler washing is more effective.

Apexior Number 1 is not a substitute for feed-water preparations or chemical treatment. It supplies protection for metal in service under boiler water and steam temperatures and pressures, supplementing the work of the chemist and water service engineer by increasing the durability and raising the service quality of the boiler metal.

It has been demonstrated on a number of railroads that Apexior surfaced metal means longer life of flue and sheet steel under boiler water, lower average maintenance costs and easier and more effective boiler washing.

Fig. 1 shows a piece of standard flue partially surfaced with Apexior or Apexiorized. The entire tube was passed through a sand-blasting machine before the application. Sand-blast cleaning is not essential. It is, however, considered to be the most satisfactory cleaning method. Any steel surface that is dry and free from loose rust, scale, dirt or oil will bond properly with Apexior for better service.

Badly pitted flues which were on the road to the scrap pile have been reclaimed, surfaced with Apexior and placed in active equipment.

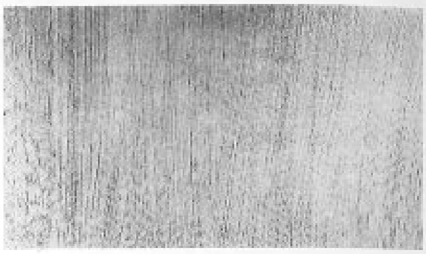


Fig. 2.—Apexior surfaced boiler plate, after two years service under 215 pounds steam pressure

Fig. 2 shows a section of Apexior surfaced boiler plate after two years' service at 215 pounds per square inch pressure. No metal is exposed and the protective surfacing remains intact.

Service experience approaching five years on locomotive shells is now available. It has been fully demonstrated that Apexior is effective to retard or check corrosion and pitting. It is indicated that Apexior proofing of staybolts may have interesting possibilities.

Apexior Number 3 is a protective surfacing material for the interior of general tank and tender equipment. It is brush-applied cold and dries a smooth, shiny jet black.

Apexior surfacing materials are well-known and have a wide distribution in stationary utility and general industrial power plants throughout the country and in the marine field. The manufacturer is The Dampney Company of America, with main office and works at Hyde Park, Boston, Mass. Branch offices are maintained at Chicago, New York, Philadelphia and Cleveland, and engineering sales representatives in other important industrial and railroad centers.

Washout Plugs for Locomotives

The Huron Manufacturing Company, Detroit, in originating the Huron washout plug, contributed something important to the efficiency of the steam locomotive.

The Huron square thread plug was designed, not with the idea of increasing the Company's sales volume, but rather to give the railroads a product which would serve and honestly give them a money saving device which would perform satisfactorily over a period of years.

The application of Huron plugs to new and old power is an investment which will show returns, and not merely an outlay of money to maintain and keep in repair

Huron square thread washout plug

washout plugs which do not give a maximum of service.

The fact that Huron plugs last the life of that part of the boiler to which they are applied is evidence enough to prove to the most skeptical that the first cost is negligible and will be entirely eliminated by the savings shown over a period of years.

Another important factor is the safety feature, and this is being proven to the railroads every day in the year by the elimination of accidents due to faulty washout plugs.

All Huron plugs are tested before they leave the factory, thereby assuring the railroads of a quality product. The sturdy steel threads will not shear or wear and are impervious to water conditions, as Huron plugs are manufactured from a solid steel forging.

Bethlehem Publishes Handbook on Alloy Steels

"Bethlehem Alloy Steels" is a valuable presentation just published by the Bethlehem Steel Company, Bethlehem, Pa., in the form of an illustrated, indexed handbook designated Catalog No. 107, whose 376 pages span the history of modern alloy steels. It is devoted exclusively to alloy and special steels in the form of bars, billets, blooms and slabs.

The purpose of the handbook is to give users of alloy steels dependable working data on properties and performance and to bring all pertinent existing data on these alloy steels up to date in one complete volume. Bethlehem's production facilities and quality control are covered in two brief chapters which precede the six main divisions, namely: Part 1, Grades of Steel; Part 2, Steels for Specific Uses; Part 3, Testing and Properties of Steel; Part 4, Working of Steel; Part 5, Definitions of Common Terms; Part 6, Tables and Useful Information.

One of its distinctive features that will prove extremely valuable to steel treaters is the color charts of heat colors and temper colors. On these charts the colors have been reproduced with unusual fidelity, corresponding to the actual colors observed on pieces of steel under accurate temperature control.

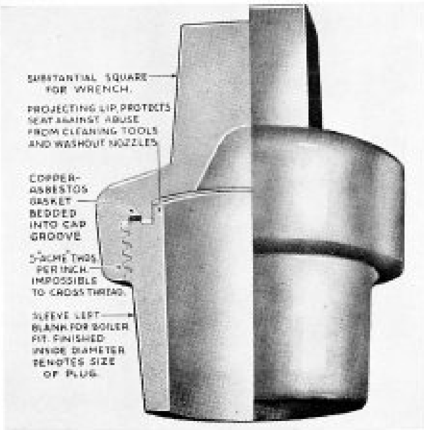
The handbook measures 6½ inches by 9 inches and is bound in green fabrikoid with raised lettering on a gold background.

T-Z Washout, Arch Tube and Inspection Plugs

The cleaning of locomotive boilers is of such importance than an efficient washout plug is very essential.

Mindful of modern locomotive requirements, The T-Z Railway Equipment Company, Chicago, Ill., has designed and is manufacturing a washout plug which meets the most exacting requirements.

In this plug are embodied three distinct features: First, no exposed threads inside the plug to fill up with dirt and scale; second, a projected lip on the sleeve which protects the seat from becoming



Features of T-Z washout plug

damaged by the use of cleaning tools and washout nozzles; third, copper asbestos gaskets bedded into a groove in the cap, which at all times makes a perfect joint and materially reduces maintenance cost. This type of joint reduces maintenance cost for the reason that it is never necessary to use special tools for refacing the joint on the sleeve or the use of an abrasive for grinding.

All T-2 washout and arch tube plugs are made of drop forged steel which gives them long life and strength sufficient to stand any pressure carried on modern locomotives.

Linde Air Products Sponsors Welding Clinics

Educational opportunities for all persons interested in the oxy-acetylene process of welding and cutting are again being offered through the medium of two welding clinics sponsored by The Linde Air Products Company. The first of these clinics will be held October 23, 24, 25, 26 in Sam Houston Convention Hall, Houston, Tex.; the second, from October 30 through November 2, will be conducted at the Georgia School of Technology, Atlanta, Ga.

Similar meetings held last year in Birmingham, Houston, Cleveland and New Orleans drew an attendance of over ten thousand engineers, plant executives, welding operators, and others who have found these clinics the best means of obtaining authoritative information on this subject. Daily programs include individual instruction in all types of oxy-acetylene welding and cutting, demonstrations of everyday applications as well as the latest developments in apparatus and techniques, discussion groups, and motion pictures. Operators and students are given an opportunity to practice under the direction of men experienced in particular phases of the process; executives and engineers can freely discuss their plant maintenance and production problems with qualified experts.

Further information and detailed programs for each of these four-day clinics can be obtained by writing to The Linde Air Products Company, 30 East 42nd Street, New York, N. Y., or to their sales offices in Atlanta, Birmingham, Dallas, Houston, Kansas City, Memphis, New Orleans or Tulsa.

Supply Trade

Republic Steel Receives Advertising Award

For the most outstanding advertising campaign of the year in the field of metals Republic Steel Corporation was awarded first prize by judges at the 13th Annual Conference of the National Industrial Advertisers Association held at Pittsburgh on September 18, 19 and 20.

S. A. Knisely, advertising and sales promotion manager of Republic, states that the prize-winning campaign was created and placed by G. M. Basford Company, industrial advertising agency, with offices in New York and Pittsburgh.

D. S. Walker made District Manager of Combustion Engineering

Don S. Walker has been appointed district manager in the Philadelphia office of Combustion Engineering Company, Inc., according to an announcement by H. S. Colby, general sales manager of the company. Mr. Walker will be responsible for sales in both the Philadelphia and Washington territories. He graduated from the U. S. Naval Academy in 1919 and subsequently joined D. H. Skeen & Company of Chicago as sales engineer, later becoming vice-president. Shortly thereafter he also became president of the Mercon Regulator Company, a subsidiary of D. H. Skeen & Company and in January 1924 resigned to become president of the Illinois Barge Line Company which was later merged with the John I. Hay Company of which he was made vice-president and chief engineer. He joined Combustion Engineering Company in December, 1934.

Removal of Republic Office

According to an announcement by N. J. Clarke, vice-president in Charge of Sales, the Pittsburgh District Sales Office of Republic Steel Corporation has been removed from 4th and Bingham Sts., S. S., to 1832 Oliver Building, Pittsburgh, Pa. The phone number of the offices in the Oliver Building will be Grant 2425. F. M. Welsh continues in charge of the office, assisted by his present staff.

The Union Drawn Steel Company, a Republic Subsidiary, will move into an adjoining suite in the Oliver Building. W. C. Gullyes, District sales manager, will be in charge.

J. F. Glenn Joins Foster Wheeler Staff

John F. Glenn, who is widely known in the power plant boiler manufacturing industry, has been appointed to the New York office sales division of Foster Wheeler Corporation. Mr. Glenn has been associated with the Foster Wheeler sales activities for the past two years and has previously been connected with other boiler builders. For eleven years Mr. Glenn was in charge of various sales offices for the Wickes Boiler Company.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—John M. Hall, Washington, D. C.
Assistant Chief Inspector—John B. Brown, Washington, D. C.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Director—Joseph B. Weaver, Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.
Vice-Chairman—D. S. Jacobus, New York.
Acting Secretary—M. Jurist, 29 W. 39th Street, New York.
Honorary Secretary—C. W. Obert, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—William H. Furman, Albany, N. Y.
Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.
Vice-Chairman—F. A. Page, San Francisco, Cal.
Statistician—L. C. Peal, Nashville, Tenn.

International Brotherhood of Boiler Makers, Welders, Iron Ship Builders and Helpers of America

Editor-Manager of Journal—L. A. Freeman, Suite 524, Brotherhood Block, Kansas City, Kansas.

International Vice-Presidents—Joseph Reed, 3753 S. E. Madison Street, Portland, Ore.; W. A. Calvin, Room 402, A. F. of L. Building, Washington, D. C.; Harry Nicholas, 6215 S. Benton Blvd., Kansas City, Mo.; W. E. Walter, 637 N. 25th Street, East St. Louis, Ill.; J. H. Gutridge, 2178 South 79th Street, W. Allis, Wis.; W. G. Pendergast, 1814 Eighth Avenue, Brooklyn, N. Y.; W. J. Coyle, 424 Third Avenue, Verdun, Montreal, Quebec, Can.; A. M. Milligan, 262 Trent Avenue, East Kildonan, Man., Can.; J. F. Schmitt, 28 S. Roys Street, Columbus, Ohio; William Williams, 1615 S. E. 27th Avenue, Portland, Ore.

Master Boiler Makers' Association

President: O. H. Kurlfinke, boiler engineer, Southern Pacific Company, 65 Market Street, San Francisco, Cal.

First Vice-President: Franklin T. Litz, foreman boiler maker, C. M. St. P. & P. R. R., 2265 Roosevelt Street, Dubuque, Ia.

Second Vice-President: Ira J. Pool, district boiler inspector, Baltimore & Ohio R. R., 5610 Merville Avenue, Baltimore, Md.

Third Vice-President: L. E. Hart, foreman boiler maker, Atlantic Coast Line, 621 Hammond Street, Rocky Mount, N. C.

Fourth Vice-President: William N. Moore, general boiler foreman, Pere Marquette R. R., 625 College Avenue, S. E., Grand Rapids, Mich.

Fifth Vice-President: Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis (Big Four), 814 Big Four Building, Indianapolis, Ind.

Secretary: Albert F. Stiglmeier, general foreman boiler maker, N. Y. C. System, 29 Parkwood Street, Albany, N. Y.

Treasurer: William H. Laughridge, retired general boiler inspector, Hocking Valley R. R., 537 Linwood Avenue, Columbus, O.

Executive Board—Chairman: J. L. Callahan, general boiler inspector, Chicago Great Western R. R., Oelwein, Ia.

American Boiler Manufacturers' Association

President—Owsley Brown, Springfield Boiler Company, Springfield, Ill.
Vice-President—S. H. Barnum, The Bigelow Company, New Haven, Conn.
Secretary-Treasurer—A. C. Baker, 709 Rockefeller Building, Cleveland.

Executive Committee (Three years)—Walter F. Keenan, Jr., Foster Wheeler Corporation, New York. E. E. Knobloch, Union Iron Works, Erie, Pa. C. W. Miller, E. Keeler Boiler Company, Williamsport, Pa. A. G. Weigel, Combustion Engineering Corporation, New York. (Two years)—F. H. Daniels, Riley Stoker Corporation, Worcester, Mass. M. E. Finck, Murray Iron Works, Burlington, Ia. A. G. Pratt, Babcock & Wilcox Company, New York. (One year)—A. W. Strong, Strong-Scott Manufacturing Company, Minneapolis. R. B. Mildon, Westinghouse Electric & Manufacturing Company, Philadelphia, Pa. R. B. Dickson, Kewanee Boiler Corporation, Kewanee, Ill. (Ex-Officio)—Owsley Brown, Springfield Boiler Company, Springfield, Ill. S. H. Barnum, The Bigelow Company, New Haven, Conn.

Office of Industrial Recovery Committee,
15 Park Row, New York

Manager—James D. Andrew.
Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President—Murrel J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Boiler Maker and Plate Fabricator

Revisions to A. S. M. E. Boiler Code

It has been customary as proposed revisions and addenda to the A.S.M.E. Boiler Code and to the Code for Unfired Pressure Vessels were made available to publish such information for the benefit of our readers. The object has been to advise anyone connected with the boiler manufacturing and pressure vessel fabricating industries of proposed changes, in order that an opportunity might be provided for criticism and suggestion before such changes were finally adopted by the Boiler Code Committee of the American Society of Mechanical Engineers.

It is apparent in some cases that proposed provisions as published in BOILER MAKER AND PLATE FABRICATOR have subsequently been used for reference. Comparatively few of the revisions are altered before final adoption but in some instances, as a result of constructive suggestions, the provisions as finally adopted are at variance with the original proposals.

When our readers have occasion to refer to revisions and addenda of the A.S.M.E. Boiler Code, or other codes of the society, the pink revision sheets issued by the Boiler Code Committee should be used.

In order to serve our readers to best advantage, all revisions and addenda pertinent to the industries covered will also be published in BOILER MAKER AND PLATE FABRICATOR, after they have been adopted in final form by the Boiler Code Committee.

Better Business

With the year rapidly drawing to a close, and with the prospects of a continued improvement in business generally, it is both encouraging and to be expected that the boiler manufacturing and plate fabricating industries should show evidences of a brighter outlook.

The latest figures of boiler production as compiled by the Department of Commerce, Bureau of the Census for the first nine months of the year indicate that production has exceeded that of the same period in the years 1934 and 1933. In May a monthly production peak was reached amounting to about 950 boilers, having approximately 620,000 square feet of heating surface. The succeeding month witnessed a rapid decline which leveled off at just over 500 boilers. Since then the rise has been consistent, until in September, 829 boilers having 575,031 square feet of heating surface were built. There has been every indication that this improvement of recent months will be maintained.

In spite of the drop in May production, which situation fortunately was corrected quickly, the first nine months' record totals 5069 boilers built, having a heating surface of 4,309,092 square feet, as compared with 3535 units of 3,406,353 square feet in the corresponding period of 1934, and 3099 boilers of 3,795,707 square feet in 1933.

This gain above 1934 of 43.5 percent in number and 32 percent in area of heating surface constitutes a real measure of recovery in the boiler manufacturing industry.

During the same nine-month period the fabricated steel plate industry has not fared quite as well. However, there are extremely hopeful signs that when the year's record is finally complete, production will have exceeded that of the previous year. The year 1934 was characterized by widely fluctuating demands, while the present year, which witnessed a considerable slump in the spring months, since April has shown a steady rise in orders. For the nine-month period of 1935, orders totaled 173,085 tons. During the same period last year 182,757 tons of plate products were booked. In September, the last month for which complete figures are available, new orders amounted to 31,105 tons, the heaviest demand since March, 1934. In contrast with 1934, it is evident that a peak in production will be reached in the closing months of this year.

Master Boiler Makers' Association

Now that the practical information concerning locomotive boiler practice presented at the 1935 Business Meeting of the Master Boiler Makers' Association has been widely distributed among railway officials and members of the association, there can be no question but that the meeting was very much worth while. A steady demand has developed for copies of the October issue of BOILER MAKER AND PLATE FABRICATOR, containing the proceedings. A measure of the value of the information is indicated by the request of one superintendent of motive power for twenty copies of the proceedings to place in the hands of master mechanics over his entire system.

While the recent meeting was extremely productive, it is well for officers and members of the association to consider possibilities and to plan constructively for the future. Because of the conflict of opinions during the spring of 1935 as to whether or not official sanction should be given this business meeting, it was more or less impossible for as complete a program to be arranged as might be done under more favorable circumstances. It should be possible in planning the meeting for next year to decide upon the subjects to be covered by reports and discussion in the near future, in order that committee assignments may be made. If reports are completed some time before the date of the meeting, preprints of the papers can be distributed to all members sufficiently in advance to provide an opportunity for preparing written discussions. When this procedure is followed, the resulting discussion inevitably is of far greater value than can be obtained spontaneously from the floor of the meeting, when members hardly have had time to read the papers.

Definitely the Master Boiler Makers' Association has demonstrated that a successful and productive meeting can be held under existing conditions. It remains for the officers and members to display a progressive spirit and take advantage of their opportunities to advance to new heights of service to the railroads in the future.

Causes of material failures resulting in

Fractures in Watertube Boiler Drums*

By Edward Ingham

Watertube boilers are sometimes described as safety boilers. They are no more entitled to be so described than are other types of boiler. Explosions of the tubes are not by any means rare; nor are disastrous drum explosions out of the question. It is true that the evaporation is mostly effected in the tubes, and that these are of small capacity, wherefore, in the event of a tube failure the quantity of water liberated (on which the destructive results principally depend) will be very small, and the explosion therefore of a comparatively mild character. But even if a boiler is subject only to explosions of a mild type, it is scarcely entitled to be described as a safety boiler; and since an explosion of a drum, which contains a large volume of water, and therefore a large amount of explosive energy, is not out of the question, the term "safety," as applied to a watertube boiler, is singularly inapt. Indeed, to speak of a watertube boiler as a safety boiler is inadvisable, for it may lead to a false sense of security on the part of those in charge, so that the boiler may not receive the vigilant attention it would do if its explosive possibilities were fully realised.

During the past few years, a number of disastrous drum explosions have occurred, the consequence of fractures in the plates, and the subject of our article should then be of interest to all concerned with boilers of the watertube type.

In America and on the Continent, drums of welded construction appear to be extensively used, but in the United Kingdom, they are almost invariably of the riveted type, except for unusually high pressures, for which only drums forged from solid steel are suitable; hence, our remarks will be confined to riveted drums.

Causes of drum fractures include (1) faulty material; (2) unsatisfactory features of design; (3) punishment received by the plates during construction; (4) chemical embrittlement of the plates.

It has long been the practice to specify that the material used in the construction of drum plates shall be made by an approved process, and that it shall not contain an undesirable amount of certain elements, such as sulphur and phosphorus, which are known to be detrimental; further, that the finished plates shall be free from laminations, surface flaws, etc. Specimens must also be subjected to various tests, with the object of ensuring that the plates will be entirely satisfactory. The result is that the plates are generally sound and originally free from defects, and hence, fractures from the use of faulty material are somewhat rare.

Many fractures have been attributed to excess of sulphur or phosphorus in the steel, but whether or not always rightly so may be questioned. For a long time, it was not suspected that nitrogen has a tendency to make steel unreliable, and it may be that this element has been the main cause of certain plate failures which have been put down to other elements. A very small quantity of nitrogen renders steel brittle, and since basic open-hearth steel is liable to contain an undesirable amount of this element, it cannot be wondered at that leading authorities are against the employment of such steel for boiler plates, and insist on having the more reliable open-hearth acid steel.

To be entirely satisfactory, a watertube boiler drum ought to be truly circular and of uniform thickness throughout; while the end plates should be suitably cambered, and have an ample radius where the edge of the plate is flanged over for attachment to the shell, i.e., at the rounded or corner part of the flange. When these conditions are not complied with, the drum is likely to be subjected to undue stresses which may sooner or later cause cracks and fractures.

The employment of the lap joint for the longitudinal seams throws the drum out of true circularity, and leads to straining at the seam which may ultimately be responsible for grooving and fracture. Butt-jointed drums are unquestionably less liable to fracture than are lap-jointed drums, and are almost invariably adopted in the best practice.

Pronounced or sudden changes of thickness of circular drum plates, such as are sometimes made at parts where the tubes are to be expanded into the plates, have a tendency to induce straining and consequently grooving, and for this reason should be avoided as far as practicable.

For similar reasons, the pressing of flats into the plates for the reception of tube ends must be regarded as undesirable; fractures are by no means uncommon at the parts where the form changes through the provision of these flats.

End plates are subject to a breathing or "drum head" action owing to the changes of pressure and temperature which take place within the drum under working conditions. This action is more pronounced the flatter the plate, or the larger the radius of the camber, and its tendency is to induce more or less severe straining at the corners of the flanges. This straining is indeed a common cause of grooving and fracture in end plates. An actual case is illustrated by Fig. 1, which shows grooving and cracking in one of the end plates of a large drum of a watertube boiler.

Obviously, the radius of the camber ought to be as small as practicable. If it is made one-half the diameter of the drum, the end plate will be hemispherical, and this form of end plate is certainly the best so far as strength and immunity from the developments of defects are concerned. If the adoption of the hemispherical end is impracticable, the cambered end ought to have a radius of about two-thirds of the drum diameter, and never more than the drum diameter.

The tendency to straining and grooving in a cambered end plate is greater the smaller the radius of the flange corner. When the radius is too small, there is not only excessive straining at the corner under working conditions, but the flanging of the plate during construction seriously distresses the material about the corner. Indeed, with an unduly sharp corner, subsequent grooving

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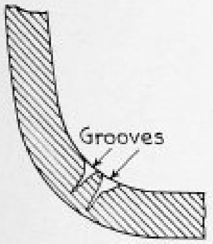
* From an article appearing in the *Transactions* of the Institute of Marine Engineers, London. Credit is also extended to *Engineering and Boiler House Review*.

and cracking are almost inevitable. Hence, the radius should be as large as practicable. A leading authority on boiler construction recommends that the internal radius of the corner should be one-eighth the radius of the camber (which, as already stated, should be about two-thirds of the drum diameter), but in no case less than two inches.

During the construction of the boiler, the drum plates have to be bent to the circular form, riveted and calked, while the end plates have to be dished, flanged, etc. These various operations are a severe test on the material, which is consequently very likely to be injured unless the work is most carefully carried out by high-class machinery and highly-skilled men. There is no doubt that a considerable proportion of the fractures which have developed in boilers of all kinds, are largely the consequence of punishment the plates have received during construction.

The bending of thick drum plates to the circular form is a more drastic operation than the bending of the shell plates of large cylindrical boilers, because the diameter of a drum is comparatively small. If the bending is done cold, serious internal stresses may be induced in the material. A suitable heat treatment applied afterwards will relieve any such stresses, and minimize the danger of fractures later.



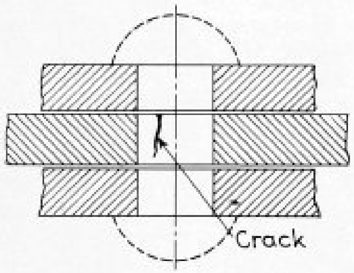


Fig. 1. (Left) Typical fracture in watertube boiler drum. Fig. 2. (Right) Dangerous type of plate fracture between the rivet holes

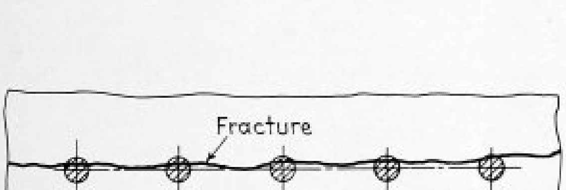


Fig. 3.—Concealed crack in lap joint

A boiler shell is weakest at the seams, because of the weakening effect of the rivet holes, and it may therefore be easily imagined that, if excessive riveting pressures are applied to the rivets, or if the practice of drifting is resorted to for the purpose of bringing the holes fair with one another (i.e., inserting a taper tool of circular section in the holes, and driving it up with a sledge hammer) the material may be seriously injured. The most dangerous fractures are those which occur at the longitudinal seams, and they may often be traced to careless riveting and to drifting.

As already mentioned, end plates may be severely distressed by flanging, especially when the radius of the corner is small. They may also be damaged by the careless operation of the pressing-out tool which is sometimes used to press out the flange against the shell plate in order to make it a good fit before the riveting is commenced. Thus the tool may be applied with excessive force, or it may be applied beyond the straight portion of the flange, so that it makes an indentation in the root of the flange. Any such indentation is a most serious defect, because it leads to concentration of stress at a part which is subjected to repeated straining under working conditions.

Calking of the riveted seams, i.e., "burring" down a strip of metal at a plate edge on to the adjacent plate, with the object of making the seam tight, is an operation which may engender dangerous fractures if it is not done wth care. The tool used is similar to the ordinary chisel, as used for metal work, but it has a flat narrow edge, commonly with sharp corners. In modern boiler shops, the tool is worked by pneumatic pressure, delivering violent blows to the plate edge. Want of care may clearly result in the sharp edges of the tool indenting the adjacent plate. As regards the internal calking of a drum, there is always the difficulty that, owing to the rapid curvature of the drum, the operator is compelled to hold the tool at a rather steep angle when calking the longitudinal seams, and the danger of indenting the plates is therefore considerable. The risk can be much reduced by making the tool of a suitably curved form, instead of the usual straight form, and slightly rounding the corners to remove sharp edges.

There is nothing more liable to injure the plates than "flogging" them, or hammering with sledge hammers to adjust or shape them. The practice of hammering the ends of shell plates to bring them to the circular form of the shell (when the bending rolls have been of the type which is incapable of bending the plates right up the edges), and also that of hammering the flanges of end plates to make them fit up against the shell, cannot be too strongly condemned.

In various kinds of boiler operations, the greatest care needs to be taken to avoid working the plates at a "blue heat" i.e., at temperatures between a red heat and cold; otherwise, the material may be injured and liable to fracture.

Plates into which the tubes are expanded may be injured by the application of excessive force from the expanding tool. Excessive expanding reduces rather than increases the holding power of the plates on the tubes, and when resorted to is very prone to induce cracks at the edges of the tube holes, as well as to split the ends of the tubes. A tube plate in particular requires careful treatment, because it is materially weakened by the numerous tube holes.

Within recent years, it has been definitely established that the presence in the feed water of certain chemicals may cause boiler plates to become brittle, and hence very liable to fracture. The consequence is that there is a strong tendency nowadays to regard chemical embrittlement as a common cause of boiler plate fractures. Actually, it is not a common cause, but rather an occasional one. Punishment received by the plates during construction is probably far more often responsible for fractured plates than is chemical embrittlement.

The chemical mostly responsible for the trouble in question is caustic soda. It has been amply demonstrated that if steel specimens in a state of strain be immersed in a caustic solution, they soon become decidedly brittle. A state of strain appears to be a necessary factor for the production of a brittle condition.

Soda in one form or another is largely used in the treatment of feed water. In some cases, caustic soda is employed; in others, the carbonate of soda. It is to be noted that if the carbonate is used and not the caustic soda, this does not ensure freedom from the danger of caustic embrittlement, because the carbonate, under high-pressure boiler conditions, may give up its carbonate acid, when it is converted into caustic soda, and in a watertube boiler, thanks to the high rate of evaporation, the water may then soon become heavily charged with caustic. If this water penetrates the riveted seams, the caustic becomes very highly concentrated, so that the conditions are favorable for engendering brittleness and fractures at vital parts.

As might be expected, the parts which generally suffer from chemical embrittlement are the riveted seams below the water level; but seams above the water level are not immune from trouble if priming occurs. It is one of the claims made for drums of welded construction that they are immune from the danger of chemical embrittlement, because there are no riveted seams into which the water can penetrate.

There seems good reason to believe that if the riveted seams could be perfectly closed by the riveting and internal calking, danger of chemical embrittlement would be largely eliminated, but this appears to be impossible. A plan which is sometimes adopted to prevent infiltration of the water into the joints is to introduce between the plates a liquid cement which afterwards sets and maintains tightness. The objection to this is that it tends to make the work of discovering constructional defects more difficult for the boiler inspector.

The indiscriminate use of soda and boiler compositions, most of which are largely composed of soda, is manifestly something to be avoided, and quite apart from other reasons, users of watertube boilers should treat their feed water according to the advice of a fully qualified chemist or water analyst.

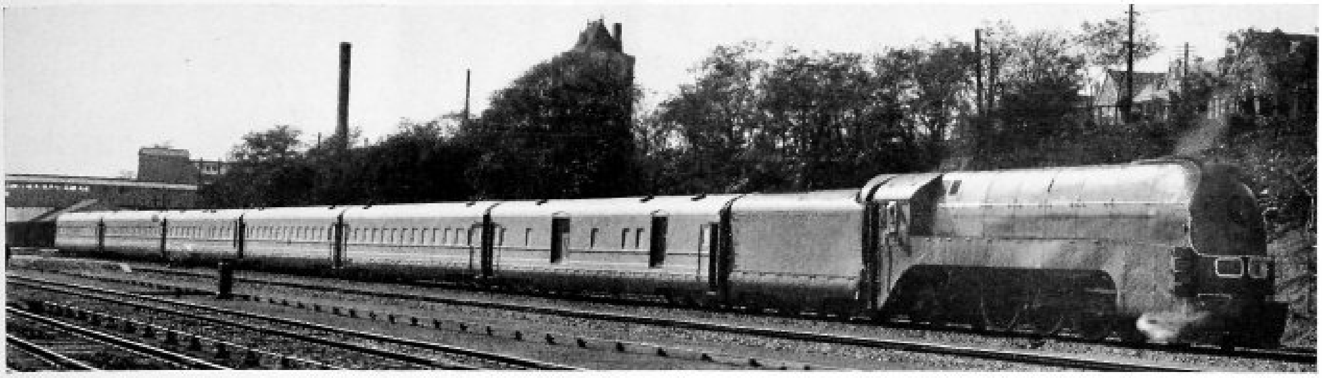
Watertube boilers are especially designed to withstand rapid steam raising, sudden changes of load, etc., conditions which, especially in some types of boiler, induce serious straining and a tendency to set up incipient fractures. Nevertheless, they should be guarded as far as practicable against sudden changes of temperature, particularly sudden cooling of hot plates, for the stresses induced by rapid contraction are always excessive and dangerous.

Since fractures in drum plates may be followed by calamitous consequences if they are not discovered in good time, regular and close inspection of all parts where they might develop is imperative. Fractures which merely run from the edges of rivet holes to the edge of the plate are not usually of much importance, because they do not appreciably reduce the strength of the drum. Those which extend from holes into the main body of the plate must be regarded as more serious. The most dangerous type of fracture is that which extends from rivet hole to rivet hole for a considerable distance (see Fig. 2). This type is all the more dangerous because, far more often than not, it starts from an inner surface of plate, i.e., at a surface which is covered by a lap in the case of a lap joint, or by a butt strap in the case of butt joint (see Fig. 3), so that it is not open to inspection, wherefore there is the possibility that it may remain undiscovered and extend until explosion results. Fortunately, however, these fractures are usually of very slow development, and as they almost invariably cause leakage, the danger of explosion can be almost eliminated if those responsible for the safety of the boiler will keep a constant lookout for leakages, and regard any leakages which are detected as being a possible indication of fracture. Leakage may of course arise from several causes, such as imperfect riveting and calking, improper bedding together of the plates at the seams, overheating, sudden changes of temperature, and the presence in the feed water of certain salts. In most cases of leakage, indeed, the cause is not a fracture, and the men in charge, knowing this, may naturally attach no significance to a leak, especially if it is not a pronounced one, and so disregard it. In doing so, they may be incurring risk of explosion. The safe plan is to look upon every leak at a riveted seam as being possibly due to a fracture, and have the cause investigated. In most instances, a little light calking (when the boiler is not under pressure) will remedy the trouble; but if the leakage persists, the advice of the insurance company should be sought. It may be necessary to withdraw some of the rivets, or even remove the butt straps, in order that a satisfactory examination can be made; and the steam user who is advised by his insurance company to do this will be wise not to demur, on the grounds of trouble and expense, as some do.

It is a feature of riveted seam fractures that they are frequently of a very fine nature, resembling hair lines, so that even when they are accessible to inspection, they are sometimes so difficult to detect by ordinary methods of inspection, that there is not a little risk of their being overlooked unless some special means are employed. Unfortunately, it has long proved an almost insuperable difficulty to devise a reliable means for disclosing very fine hidden fractures in boiler plates on the site. The X-ray was recognized as a possible means as soon as it was discovered before the end of last century, and experiments were carried out by a well-known boiler insurance company, but were not attended with success. Although notable advances have been made within recent years in the application of the X-ray to the discovery of defects in castings and forgings, the method still appears to be open to certain objections so far as the detection of fine cracks in boiler plates is concerned.

Not long ago, a method of disclosing boiler plate fractures was developed by the Vulcan Boiler Insurance Company, Ltd., of Manchester, which states that no fracture, however slight, can escape detection by this method. A powerful magnet is applied to the plate under examination, which is thereby rendered magnetic, and a special liquid consisting of a mixture of light oils containing a suspension of finely divided iron (reduced by hydrogen), is poured on the cleaned surface, whereupon the iron dust immediately accumulates along any lines of fracture owing to the change in the local distribution of the magnetic flux. In the October, 1934, issue of the *Vulcan*, the following instance of the application of the method to the drum plates of a watertube boiler is given: Leakages at the longitudinal seam suggested the possibility of a fracture there. The butt straps were removed, but there did not appear to be anything wrong with the plate. When, however, the magnetic test was applied, cracks were disclosed at various positions along the seam. As several fractures were revealed, the drum was subsequently removed; and a metallurgical investigation which was afterward carried out on the defective drum showed that the cracks had all commenced at the rivet holes on the outer surface of the plate, and had progressed both along the surface and through the thickness of the plate.

THE YOUNGSTOWN SHEET & TUBE COMPANY has announced the appointment of C. Hix Jones of its Detroit office as assistant district manager of the Detroit district. It also announced that Harold M. Pierce, for the past five years with the Newton Steel Company, has joined the Detroit organization of Youngstown Sheet & Tube.



Pacific type locomotive and six-car train fully streamlined

South Manchuria Railway features

STREAMLINED LOCOMOTIVE

One of the recent trains of the streamlined type to be placed in service is that which bears the name *Asia*, now operating on the South Manchuria Railway between Dairen and Hsinking (formerly Changchun), the capital of Manchukuo. It consists of a Pacific type steam locomotive and six or more passenger coaches, all fully streamlined.

At the present time the high-speed express train *Asia* covers the 436 miles between Dairen and Hsinking in eight and one-half hours elapsed time or at an average speed of 51.2 miles per hour.

The train was built at the shops of the railroad from materials mostly either native or of Japanese manufacture. In addition to being streamlined the train is rendered doubly striking by the color scheme adopted. The locomotive is painted a deep indigo and the coaches a light olive, with a white stripe running throughout the length of the train. Besides the locomotive there are six passenger cars; namely, one baggage and mail car, two third-class passenger cars, one dining car, one second-class passenger car and one first-class passenger and observation car. For emergency either a second-class or a first-class passenger car can be added between the last two cars.

Due to the necessity of building an engine within a limited axle weight and yet capable of producing the necessary steam for high speed operation, all parts were made as light as possible. For this reason special cast steel was used for the cylinders, nickel-steel plates for the boiler shell, high quality manganese cast steel for the

American practice adopted for design and construction of new Pacific type streamline locomotive

main frames, and aluminum alloy for the brake cylinders, steam-cylinder front covers, and all oil and grease cellars.

Though the general design is based largely upon American practices, the firebox has certain features designed to make it suitable for using Fushun coal and several other parts were adapted to local conditions.

The locomotive itself weighs 262,010 pounds, of which 157,560 pounds is on the drivers, 54,010 on the front truck, and 50,440 pounds on the trailing truck. The tender, which weighs 186,300 pounds loaded, has a capacity for 9780 U. S. gallons of water and 13.2 tons of coal. The driving-wheel base is 13 feet $7\frac{3}{4}$ inches, the engine wheel base is 36 feet and the total wheel base of engine and tender is 73 feet $6\frac{3}{32}$ inches. The two cylinders have a diameter of $23\frac{5}{16}$ inches and a stroke of $27\frac{61}{64}$ inches. The driving wheels are $78\frac{3}{4}$ inches in diameter over the tires. The valve gear is of the Walschaert type, operating 12-inch piston valves with a maximum travel of $8\frac{1}{2}$ inches and 81 percent cut-off in full gear. The tractive force at 80 percent boiler pressure is 34,950 pounds.

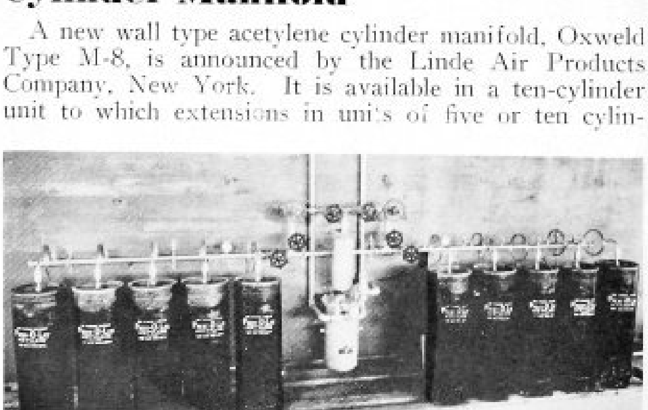
The boiler is of the extended wagon-top type, $77\frac{5}{32}$ inches inside diameter at the first course and $87\frac{27}{32}$ inches outside diameter at the third course. The boiler pressure is 220 pounds. The firebox is $114\frac{15}{16}$ inches long by $84\frac{1}{4}$ inches wide, which gives a grate area of 67.3 square feet. The firebox is fitted with a brick arch carried on arch tubes and a combustion chamber 42 inches long is provided. The boiler has 70-2-inch tubes and 132-$3\frac{33}{64}$-inch flues—the length over tube sheets being 16 feet $10\frac{3}{4}$ inches. The total firebox heating surface is 316 square feet; tubes and flues, 2671 square feet, evaporative, 2987 square feet. The Type E superheater has a heating area of 1100 square feet. The coal is fed by a steam jet type stoker. The fire door is of the butterfly type. A closed type feed-water heater is provided.

The throttle is of the multiple-valve type, the air-brake equipment Schedule 6-ET, the power reverse gear of the Alco type, and the trailing truck of the Delta type.

The application of the streamline cover to the locomotive was made in such a way as not to interfere with inspections, boiler washing, or general repair work. Pressed channels are used for the skeleton framework of the streamline cover with aluminum and bright-finished steel sheets for the cover itself. A smoke deflector was provided as shown in the photographs.

Acetylene Cylinder Manifold

A new wall type acetylene cylinder manifold, Oxweld Type M-8, is announced by the Linde Air Products Company, New York. It is available in a ten-cylinder unit to which extensions in units of five or ten cylinders can be made. This manifold consists of two high-pressure header units which feed into a central regulation system and delivers acetylene to the shop distribution piping system at pressures up to 15 pounds per square inch.



Oxweld Type M-8 wall type acetylene cylinder manifold

The header unit assemblies are composed of heavy seamless steel tubing with forged steel union connections having stainless steel seat inserts, the valves for cylinder connections being threaded directly into the steel tubing header. Connections from the header valves to the cylinder valves are made with flexible leads, coiled to provide sufficient flexibility, fitted with a flash arrester, and provided with a ball check. This guards against the possibility of acetylene from the header being driven back into an exhausted cylinder. The two high-pressure header assemblies are connected by forged steel unions to a central system of six valves and two regulators for controlling the operation of the manifold.

The pressure in each header is indicated on a high-pressure gage located on the headers near the union connections to the regulator assembly. A low pressure gage, attached to the outlet of the hydraulic back-pressure valve, indicates the delivery pressure to the shop piping.

Boiler Tube Buckling

By W. F. Schaphorst

It has been observed many times that when tubes in horizontal watertube boilers buckle, they buckle upward; and on the other hand in the fire-tube type of boiler the tubes buckle downward.

The following explanation will show why the tubes buckle as they do, in opposite directions.

When the steel of which boiler tubes are made becomes heated, it naturally weakens, and therefore the hottest side is the weakest side. In the watertube boiler, the weakest side is on the bottom because the bottom is hottest. The forces acting on the tube when in operation are compressive forces and are equal and opposite in direction, acting from the ends parallel with the tube. The hottest side compresses more readily than the cooler side, and therefore in the case of the watertube boiler the buckling is upward.

For the same reason, the upper side of the fire-tube boiler is the hottest and therefore the weakest side. Consequently, the buckling is downward.

Another contributory cause is soot. Soot and ash always deposit to greatest depth on the top or outside of the horizontal watertube boiler. The top side is therefore insulated against heat while the bottom is not. And in fire-tube boilers soot and ash deposit on the bottom or inside of the tubes. Therefore, the bottom is insulated against heat while the top is not. In other words, it is perfectly natural for horizontal watertubes to buckle upward and for fire-tubes to buckle downward.

If the buckling were caused solely by the expansion due to the difference in temperature on the two sides—that is, if there were no change in strength—the buckling would be in the direction opposite to that described. The buckling is always away from the side of least resistance. That is, the hottest, and therefore the weakest side, always becomes concave.

A study of the theory and practice of columns will explain fully why buckling is always such that the hottest side becomes concave. However, it is hoped that the above has been made plain enough so that anybody can now understand clearly why tubes buckle as they do.

HIGH PRESSURE BOILERS

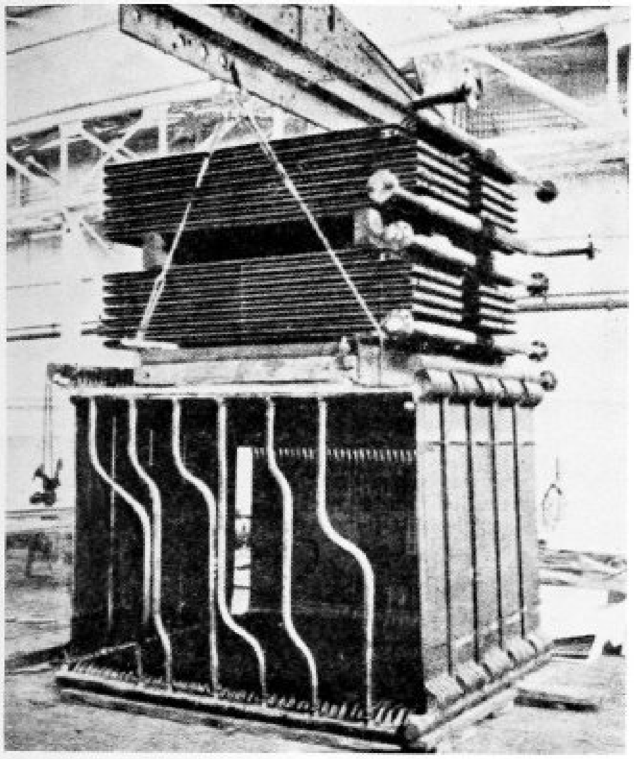


Fig. 1.—Benson boiler as erected in the shop

Benson Type of Super-Pressure Marine Boiler*

By Dr. E. Goos

The only super-pressure steam boiler installed in a merchant vessel up to the present time, as far as is known, is the Benson boiler designed and constructed by Messrs. Blohm and Voss, Hamburg. This boiler has now been in continuous service on the S. S. *Uckermark* for about four and a half years and has worked to the entire satisfaction of all concerned. In view of this, the Hamburg-American Line decided to have the new turbo-electric driven ship now in course of construction at the yard of Blohm and Voss for their service to the Far East fitted with four Benson boilers.

As is generally known, the Benson boiler consists entirely of tubes and has no drums, and these constructional features render it very suitable for use on board ship. The boiler has a comparatively large combustion space, entirely surrounded by tubes, through which water passes in continuous flow so that no stagnation can take place in any of them. The flow of water and steam is shown diagrammatically in Fig. 2, together with the path of the combustion gases. The heat transmission from gas to water or steam in the radiation part, as well as in the convection part of the boiler, can be exactly calculated, because the question of heat transfer has been thoroughly investigated and accurate coefficients have been established by numerous trials. For this reason it is possible to determine that part of the boiler where the water is converted into steam and where salts or other impurities of the boiler water are deposited. The temperature of the combustion gases in this part of the boiler must be low to prevent the formation of hard scale inside the tubes. By this simple but ingenious measure, it is possible in the case of a leaky condenser to maintain full power for several hours without danger of tube failures. As the working principle of the boiler also prevents the occurrence of priming, the boiler can be considered as especially suitable for marine purposes.

Originally the Benson boiler on the *Uckermark* worked at the critical pressure, but it has been shown that the boiler can also be worked at variable pressures as long as the conversion zone is situated in the region of low gas temperature. On this account the boiler pressure is virtually subject to no practical limitations and may be kept as high as 3000 pounds per square inch according to the type of turbine selected or the power temporarily necessary. The temperature of the superheated steam is automatically kept constant by an apparatus of special design and is, by considerations of the material available, limited to about 900 degrees F.

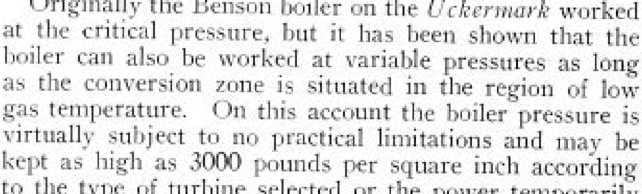


Fig. 2.—Diagram of Benson boiler showing temperature and flow of feed water and steam and temperature and flow of air and combustion gases

* Abstract of paper presented before Institute of Marine Engineers, London, Eng., March 12, 1935.

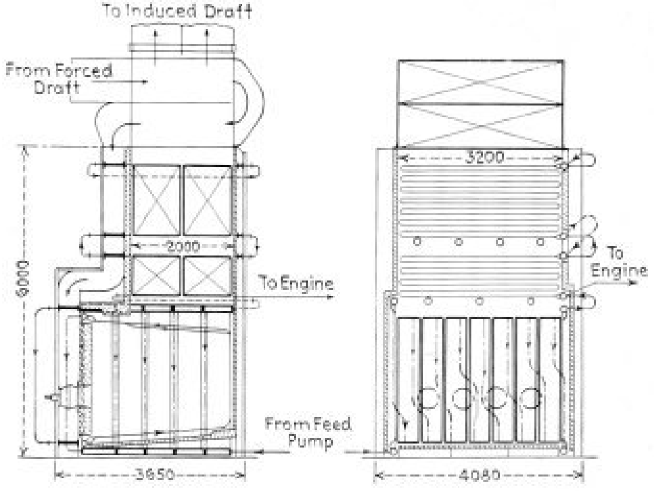


Fig. 3.—Benson boiler "497"

One of the boilers for the before-mentioned new vessel is shown in Fig. 3 and the design will be readily understood by reference to the diagram, Fig. 2. The weight of this Benson boiler is only 3 tons and the space 100 cubic feet per ton per hour of steam at 1500 pounds pressure and 900 degrees F. It should be particularly pointed out that in special cases, where the saving of weight and space is of vital importance, these values can be reduced to 0.7 ton and 35 cubic feet respectively. The combustion space is rectangular, and with this formation excellent mixtures of the highly preheated combustion air and the atomized fuel is secured, so that the combustion at all loads is complete and nearly smokeless. With properly arranged high-class oil burners, 340,000 B.t.u.'s per cubic foot of combustion space can be generated and 260,000 B.t.u.'s per square foot of radiation surface have actually been transmitted.

The tubes of the combustion space are of special steel containing 0.4 percent molybdenum; their diameter is 1 inch and the thickness is $^5/_{32}$ inch. The number of tubes in one nest depends upon the capacity of the boiler. The tubes or coils are welded on to upper and lower headers, each upper head being connected to the following lower head by one downpipe of suitable diameter. Around the boiler are air trunks provided to carry the combustion

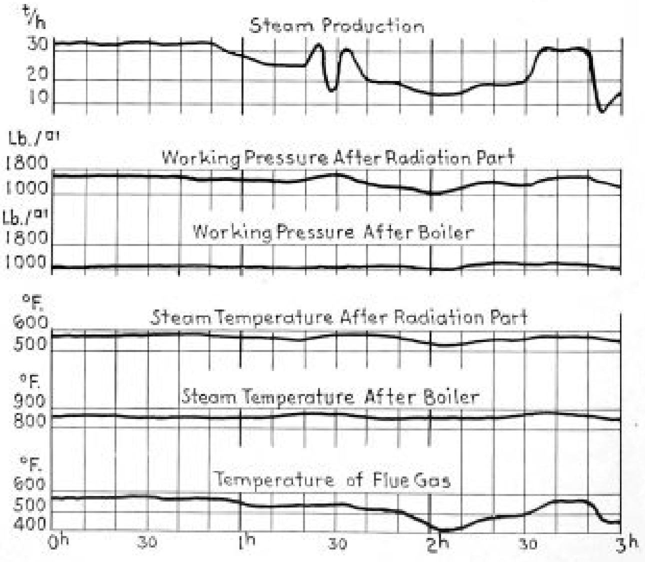


Fig. 4.—Diagram of test results

air from the pocket type air heater to the oil burners, and in view of this arrangement the boiler does not require elaborate insulation.

In Fig. 1 the boiler is shown as photographed in the shop and this picture gives a clear idea of the boiler construction.

At the works of Messrs. Blohm and Voss one Benson boiler, complete with all the necessary instruments for exact measurements, has been installed and tried under conditions approximating to the severest seagoing service. It has been demonstrated that the Benson boiler is capable of responding immediately to the required alterations of the load. Maneuvers of the turbine from stop to full ahead and vice versa can be carried out in a few seconds. The fuel pumps were regulated by the thermometer for superheated steam and relays, the number of burners, the feed pumps and the boiler fans being hand regulated. As will be seen from Fig. 4, showing the test results, all the interdependent data, steam pressure, steam temperature, etc., are subject to little variation and only within the limits permitted. The efficiency is very good, being on an average 90 percent, the same as that obtained on the *Uckermark*. The tubes can be kept clean by steam blowers; therefore the efficiency is nearly always at the same level. The oil burners used are of Blohm and Voss design, ranging in capacity from 100 to 1700 pounds per hour. The combustion is nearly smokeless at all loads, and the CO_2 content of the combustion gases uniformly recorded at 14 to 15 percent.

Work of the Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information on the applicaton of the code is requested to communicate with the Secretary of the Committee, 29 West 39th Street, New York.

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the council of The American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published.

Following are records of the interpretations of this committee formulated at the meeting of September 13, 1935, and approved by the council.

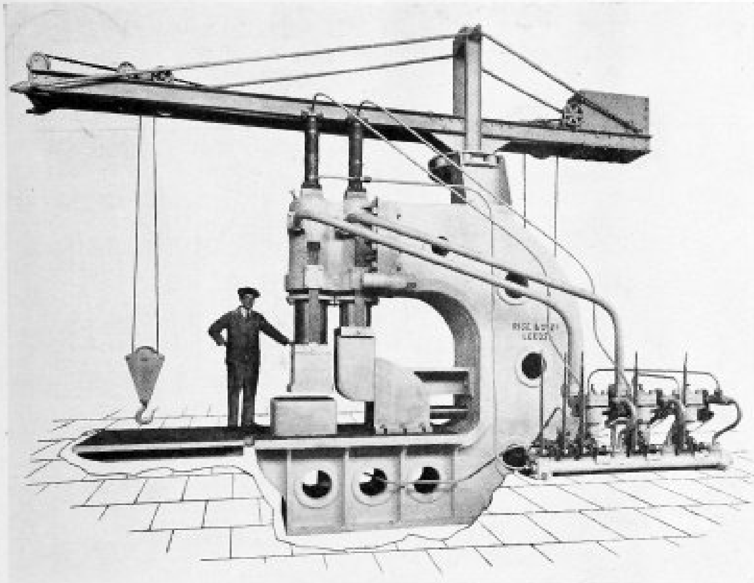
Case No. 808
(In the hands of the committee)

Case No. 809 (*Interpretation of Par. P-216*)

Inquiry: The statement in Par. P-216 would appear to include the segment above or below the tubes but Fig. P-20 does not so indicate. May those provisions be applied to the segment above the tubes?

Reply: The provisions of Par. P-216 may be applied to the segment above or below the tubes, which would permit the omission of staying if the distance from the tangent to the upper side of the top row of tubes, or from the bottom side of the lower row of tubes, to the shell does not exceed $1\frac{1}{2}$ *p*.

Cases Nos. 692, 755, 761, 763, 767, 770, 772, 773, 777, 784, 788, 789, 790, 794, 799, 801, 803 (Annulled).



British machine for flanging boiler plate

FLANGING PRESS

By John D. Watson

A new machine being successfully operated in some of the British boiler shops for the purpose of flanging boiler plates, is shown herewith. It is well known, that for circular heads, dies of the ring type while suitable for relatively small and thin plates become costly when used for flanging the comparatively large diameter thick plates associated with modern boiler work. This machine, which operates on the progressive system, is claimed to be a good deal cheaper to operate, but able to do very good work.

It will be seen that the equipment is quite self contained by reason of its hydraulic crane which can lift up to 4 tons. With a radius of 15 feet and a lift of 9½ feet, it has a counterbalanced jib mounted on the main standard of the machine with a hand chain to operate the slewing and racking motions which are quite easily done by hand because there is a footstep ball bearing and a roller track as shown, on the bracket. An anvil block fixed to the table and a plough block secured to the inner of the two vertical rams are the only dies required.

For the purpose of flanging a circular boiler head, for which operation the machine has been primarily designed, the portion of the plate which has been heated at the part to be flanged is placed on the anvil block and gripped by the outer vertical ram. The inner ram, which carries the plough block, then descends and turns down the edge of the plate. After this ram has been withdrawn upwards, the horizontal ram is advanced rapidly to square up the flange against the edge of the anvil block. This horizontal ram works in a guide block bolted to the table and that block, too, takes the horizontal thrust on the plough block. Although the sequence or rather combination of operations has taken a little while to describe, it only takes a few seconds in practice and is repeated, of course, till the whole plate is flanged.

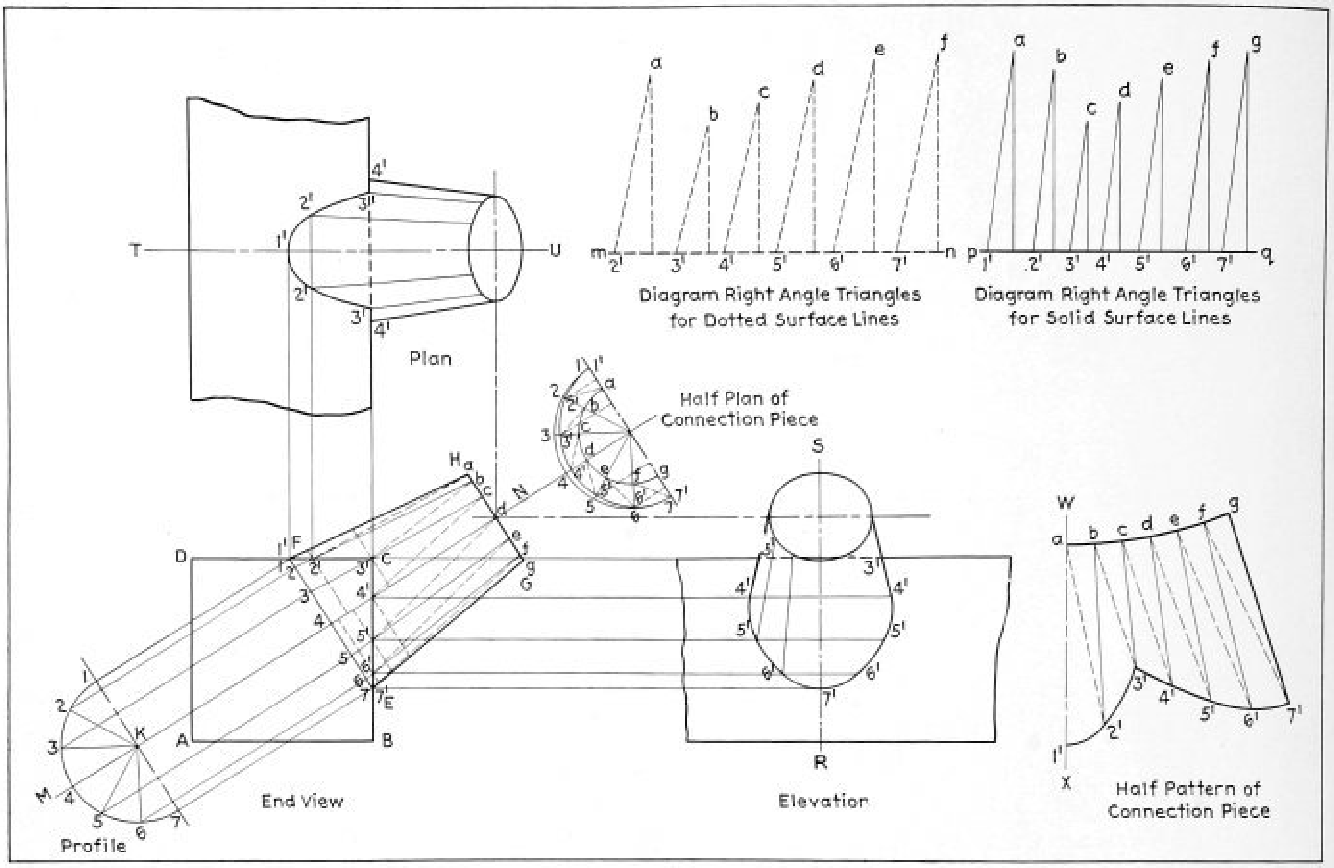
To the center of the plate itself, an attachment is fitted so that it can be centered on an adjustable pivot which can be fitted in any position on the extension plate to the left which, it will be observed, is hinged to the main table. This insures that the plate will be flanged to a true circle. In the particular unit described the extension plate is 5 feet long and the table 7 feet long, both being 4 feet wide. The length of the extension plate is the only limit to the size of plate that can be flanged. The press gap, it might be noted, is 5 feet.

By means of full blocks, small end plates can be flanged in one operation. In this case, the entering block is bolted to both the vertical rams which then move together with a combined force of some 200 tons. A jack ram is fitted to the table midway between the two main vertical rams and this ram, which exerts a force of 40 tons, can be used for pushing the plate out of the bottom block after flanging. The main rams, which are 14 inches in diameter, with a stroke of 2 feet, are intended to exert a force of 200 tons each. In order to insure that there will be a minimum of deflection, both the standard and the cylinders are Siemens-Martin steel castings. The 12-inch horizontal ram with a stroke of 16 inches exerts a force of 75 tons and it is used, as stated, for squaring up the flanges.

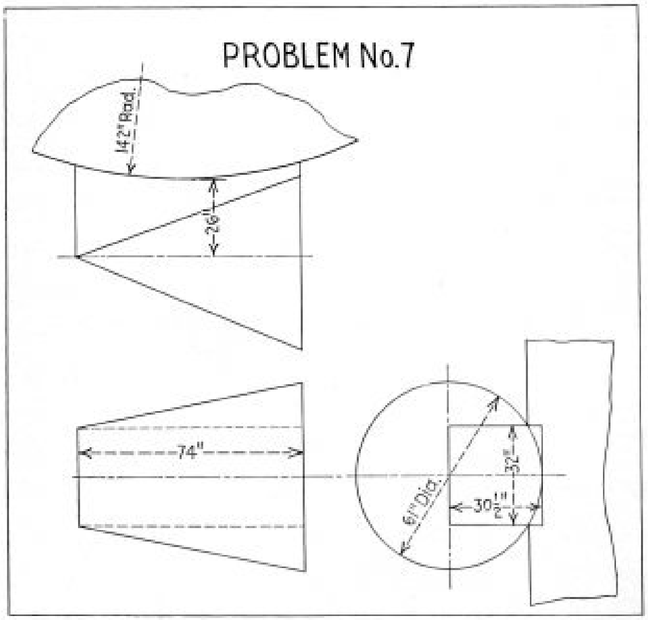
The somewhat comprehensive array of valves has a definite purpose, that of saving water and of controlling each of the three rams by means of a single lever. They work in conjunction with the draw back cylinders which are seen to be mounted above the main ones. The valve first admits water above the piston in the small cylinder and the resulting downwards movement of the main ram draws in water from an overhead tank. As soon as the ram encounters any resistance, the pressure in the small cylinder increases. This increased pressure then acting on a differential spindle in the filling valve causes this valve to open and in doing so, to admit pressure water to the main cylinder. This arrangement of valves, therefore, saves an appreciable amount of power without in any way reducing the speed of the rams.

Universal Electric Tools.—A recent Bulletin of the Chicago Pneumatic Tool Company, New York, illustrates and describes the new line of universal electric tools. The tools shown are all new and have only recently been offered to the trade. They include standard and heavy duty drills of various types and sizes.

Problem No. 5 — Correct Layout



Solution of "Connection Piece" practice problem, appearing on page 218 of the August issue



Problem No. 7—For Readers to Lay Out

Practice Problem No. 7, shown at the left is intended to demonstrate the principles described in connection with the "Air Duct Shoe" layout published in the present instalment of the series by Mr. Davies, on "Practical Plate Development." After studying the problem as explained, the reader who has been following the series with the idea of developing skill in layout work, should apply the method to this practice problem. The correct layout will be published in January

PRACTICAL PLATE DEVELOPMENT—VIII

Air Duct Shoe

By George M. Davies

The air duct shoe illustrated, consists of a round to oblong connection piece setting adjacent and connecting to a square duct.

The elevation, plan and end views are shown in Figs. 69, 70 and 71 respectively.

From an inspection of the elevation, plan and end views it will be noted that the shoe consists of three parts, the back of the shoe as illustrated in the end view by *A'-S-R-B'*, the front piece as illustrated in the end view by *H-R-S-K* and the shoe proper, which is composed of portions of two scalene cones joined by a flat triangular surface as *A-F-B* in the elevation and a flat top and bottom section as shown by *B'-H'-R'-C* of the plan view.

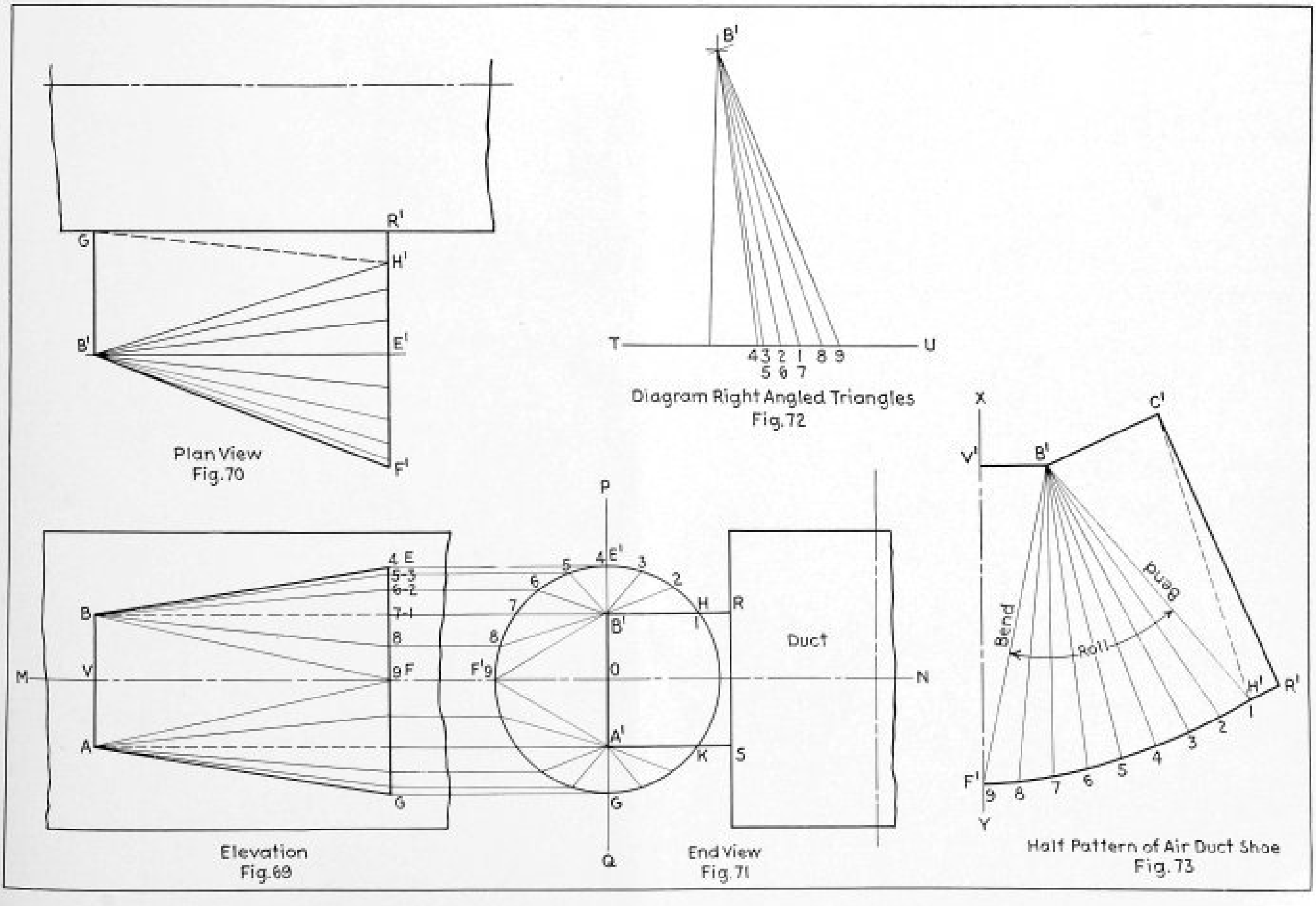
Before proceeding to develop a pattern of the shoe proper it will be noted that the center line *M-N* divides the elevation and end views into two symmetrical halves, and therefore a development of one-half the shoe can be duplicated for a complete pattern.

Divide the arc *H-E'-F'* of the end view, Fig. 71, into any number of equal parts, the greater the number of equal parts taken the more accurate the final development. Number the divisions from 1 to 9, as shown, then parallel to *M-N* draw line through the points 1 to 9, Fig. 71, extending these into the elevation cutting the line *E-G*. Number these intersections from 1 to 9 corresponding to the same points in the end view, as shown.

Connect the points 1 to 9 of the elevation, Fig. 69, with the point *B*, these lines represent the surface lines of the scalene cone.

In order to obtain the true length of these surface lines it will be necessary to erect a series of right angle triangles.

Connect the points 1 to 9, Fig. 71, with the point *B'*, these lines will be the bases of the right angle triangles as shown in Fig. 72.



Air duct shoe, consisting of a round to oblong piece connecting to a square duct, in developed form

To construct the right angle triangles shown in Fig. 72, draw any line as *T-U* and erect a perpendicular to it. From the base line *T-U* set off on the perpendicular the distance *B'-E'* of the plan view, Fig. 70, locating the point *B'*, Fig. 72. From the perpendicular set off on the base line the distances *B'*-1, *B'*-2 to *B'*-9 of the end view, Fig. 71 locating the points 1 to 9, Fig. 72. The distances *B'*-1, *B'*-2 to *B'*-9, Fig. 72 are the true lengths of the corresponding surface lines in the elevation, Fig. 69.

Constructing the Pattern

To construct the pattern draw any line as *X-Y*, Fig. 73, and step off the distance *V'-F'* equal to *B'-F'* of the plan, Fig. 70. Then with *V'*, Fig. 73, as a center and with the trams set equal to *V-B* of the elevation scribe an arc. With *F'*, Fig. 73, as a center and with the trams set equal to *B'*-9, Fig. 72, scribe an arc cutting the arc just drawn locating the point *B'*, Fig. 73.

Then with the point *F'*, Fig. 73, as a center and with the trams set equal to the distance 9-8, Fig. 71, scribe an arc. With *B'* as a center and with the trams set equal to the distance *B'*-8, Fig. 72, scribe an arc cutting the arc just drawn locating the point 8, Fig. 73. Continue in this manner taking the distances 8-7, 7-6, 6-5, etc., from the end view, Fig. 71, and the distances *B'*-7, *B'*-6, *B'*-5 to *B'*-1 from Fig. 72, until line *B'-H'*, Fig. 73, is drawn.

Then with *B'* as a center and with the trams set equal to *B'-C*, Fig. 70, scribe an arc. With *H'* as a center and with the trams set equal to *H'-C*, Fig. 70, scribe an arc cutting the arc just drawn locating the point *C'*, Fig. 73.

Then with *H'*, Fig. 73, as a center and with the trams set equal to *H'-R'*, Fig. 70, scribe an arc; with *C'*, Fig. 73, as a center and with the trams set equal to *C-R'*, Fig. 70, scribe an arc cutting the arc just drawn locating the point *R'*, Fig. 73, completing the half pattern of the shoe proper.

The back of the shoe is shown in its true size in the end view as *A'-S-R-B'* and can be joined to the pattern of the shoe proper by connecting the line *B'-R* of the end view along the line *B'-C'* of the pattern.

The front section is shown in its true size in the end view as *K-S-R-H* and can be joined to the pattern of the shoe proper by connecting the line *H-R* of the end view along the line *H'-R'* of the pattern. However, there would be a considerable waste of material if this were done and therefore it would be advisable to make the shoe in three sections and either rivet or weld together after shaping the shoe.

(To be continued)

Boiler Exhibits at British Industries Fair

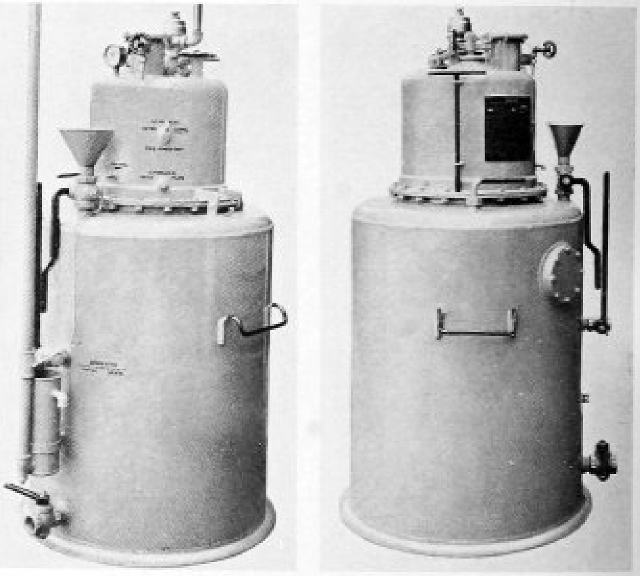
By G. P. Blackall

There were several boiler displays of outstanding interest at the heavy section of the recent British Industries Fair, which was held at Birmingham. One of the subsidiaries of Babcock & Wilcox, for example, displayed an economic boiler with patent water-cooled combustion chamber, while the Clarkson Thimble Tube Boiler Company featured a small thimble-tube silencer-boiler, as used in the electric kitchen car of the *Royal Scot*, a famous British express, and a collection of thimble tubes as employed in the various types and sizes of Clarkson boilers.

Perhaps the most interesting boiler exhibit, however, was that of Ruston & Hornsby. This included an entirely new horizontal boiler, which it is claimed has been designed to give a greater efficiency than any other type of shell boiler previously available. It is virtually an alternative to the Ruston & Hornsby vertical Thermax boiler, as this horizontal model can be used where headroom is an important consideration. The essential features of the new boiler are a wet-back combustion chamber, two sets of fire tubes, and the fact that the tubes can be cleaned while the boiler is under steam. Automatic stokers can be fitted for burning low-grade coal and the boiler can also be fitted with any recognized make of oil burner. It has attracted great technical interest.

Medium-Pressure Acetylene Generator

A new small-size medium-pressure acetylene generator for portable or stationary service has just been announced by The Linde Air Products Company, New York. Known as the Oxweld type MP-6 medium pressure generator, this latest addition to the Oxweld line



Stationary and portable medium pressure acetylene generators

of generating equipment has a 50-pound carbide capacity with a double rating of 100 cubic feet of acetylene per hour. Developed for portable or stationary use with any type of oxy-acetylene cutting or welding apparatus, it meets the demand for small, rugged, low-priced generating equipment of modern design.

A handwheel at the generator top makes it possible to control the carbide feed so that acetylene at any desired pressure up to 14 pounds per square inch may be obtained. The carbide feeding mechanism incorporates the same principle of gravity type, pressure diaphragm-control as the larger Oxweld generators.

Special automatic controls make the Oxweld type MP-6 generator particularly safe to operate. It has been tested and accepted by the Underwriters' Laboratories at the double rating for generating capacity. In addition, it has been listed for both stationary and portable service. The generator can be mounted on a truck for transportation from job to job, or fitted for permanent installation to supply medium-pressure acetylene through pipe lines.

Construction and strength characteristics of

Laminated Wall Pressure Vessels*

By T. McLean Jasper†

Fig. 1.—Failure of solid wall pressure vessel

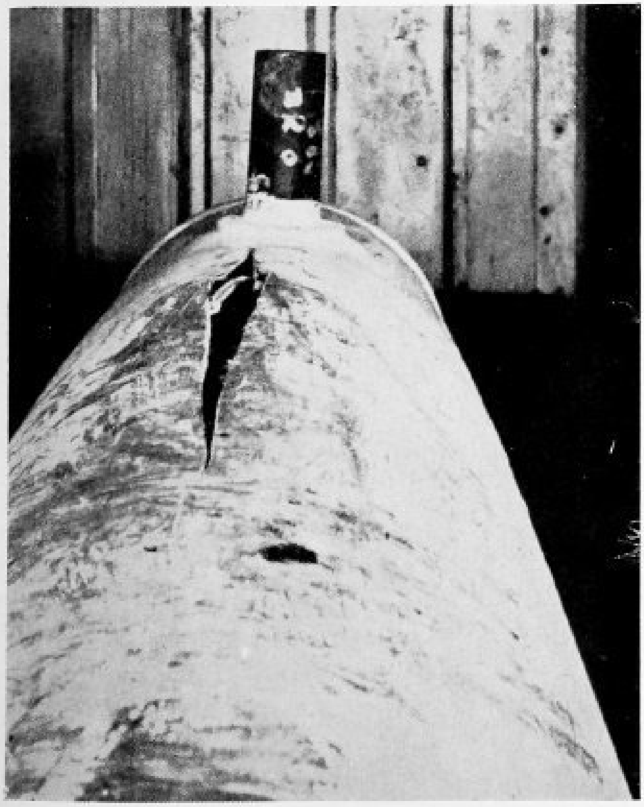


Fig. 2.—Failure of layer constructed vessel

The full value of the laminated construction for vessels to be used for high pressures has not been appreciated by users of pressure vessels until recently. The discovery of this value comes from testing solid thick wall vessels to destruction in comparison with the testing of laminated thick wall vessels to destruction. The value of laminated vessels can best be brought out by a description of their action under tests in comparison with thick solid wall vessels.

The vessels used for test comprise three solid wall vessels and two vessels composed of layers shrunk together. The solid vessels were all 26 inches inside diameter and 3½ inches thick, which represented an average D/t value of about 8.4. This D/t value has been taken to represent the relative stiffness of the vessels. The vessels composed of layer construction were each 19.25 inches inside diameter and had a wall thickness of 3.84 inches which represents an average D/t value of about 6.0 or a relative thickness greater than that of the solid wall vessels. The vessels were designed with elliptical heads and reinforced openings, and were welded throughout with the most up-to-date welding procedure. The failure occurred at locations removed from the welds or openings and the typical failure is shown in Figs. 1 and 2.

Fig. 1 gives a picture of a solid wall vessel. The wall thickness is 3½ inches. Fig. 2 shows how the layer construction vessel failed. This vessel failed at a pressure of 20,200 pounds per square inch. The other one let go at pressures of something like 17,000 pounds per square inch hydraulic pressure.

The solid wall vessels failed at an average ratio of stress at failure to ultimate strength of the steel used in their construction of 79 percent. The laminated vessels failed at an average ratio of 98 percent. The consistency of the results for each type of vessel allows no question to be raised in the writer's mind but that the facts as discovered by these tests will be representative of these two types of vessels under service conditions. The normal vessel used in industry will have a D/t value of 20 and above, and it is believed that the difference between the action of the laminated vessel and the solid wall vessel will become less pronounced as the ratio of diameter to wall thickness is increased. However, the action of a vessel with thick solid walls is far different from that of the thick wall laminated vessels in that the thick solid wall vessel fails with a shattering effect and the laminated vessel opens up with much less violence.

In the calculation of the maximum stress for the thick wall vessel, the Lamé formula was used, which is as follows:

$$S = \frac{P\,(d_2{}^2 + d_1{}^2)}{d_2{}^2 - d_1{}^2}$$

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* Abstract of papers presented at the tenth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors.

† Director of research, A. O. Smith Corporation, Milwaukee, Wis.

In the calculation of the maximum stress for the laminated vessels the following formula was used:

$$S = \frac{P}{2t} \quad \frac{(d_2 + d_1)}{(2)}$$

in which, P = bursting pressure
S = bursting stress
t = thickness of vessel wall
d_1 = inside diameter
d_2 = outside diameter

The above formulae are considered more nearly to represent the action of the respective construction methods used in the fabrication of the two types of vessels. The percentage difference, however, if only one formula is applied, is less than 2 percent for the relative thicknesses and sizes tested.

When a difference in the action of two types of construction is discovered, it is but natural to endeavor to seek the reason for its occurrence. From the above tests, the laminated construction, with the same quantity and quality of steel used, will produce a vessel which is 22½ percent stronger than if the vessel were built of solid wall construction. Of course, the above remark refers to the relative thickness of the vessels tested, and should not be applied indiscriminately to thick wall vessels of larger ratios of D/t. I am talking about vessels that are very, very thick and not about vessels such as we normally use in industry.

Fig. 3 has been developed to explain, what is believed by the author, the reasons why the laminated vessel is a superior construction. The stress condition of the thick wall vessel under no pressure is shown in diagram A, Fig. 3, by a line marked *a*. Under pressure the stress distribution is shown in Fig. 3A by the diagram marked *b*. You will notice by this diagram that the maximum stress is considerably higher than the average value. The assumption of no or low stress at no load in this construction implies that the vessel is stress relieved before service, which is necessary in this type of construction after welding.

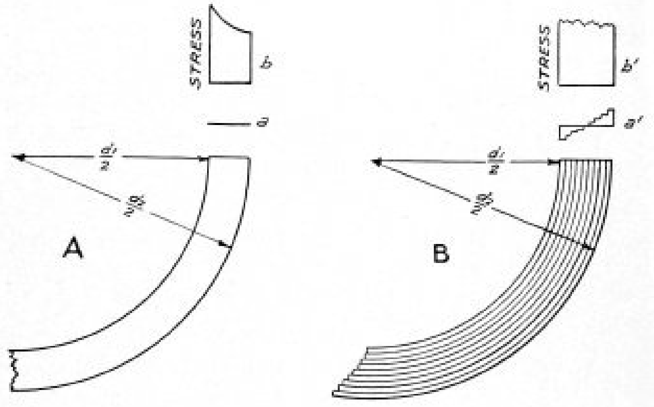


Fig. 3.—Demonstration of superiority of laminated construction

The stress condition of the laminated vessel under no load is shown in Fig. 3B by the diagram marked *a*. This condition is brought about in the manufacturing operation which results in the inner layers being under compression while the outer layers are under tension. The stress distribution in the vessel wall under full operating pressure is shown by Fig. 3B in the diagram marked *b*.

This is due to the fact that each layer is snugly compressed on to the previous layer so that the inner surface will be in compression and the outer surface will be in tension. The action of the vessel under pressure, in the solid wall vessel, is to have stress increase much more rapidly on the inside than on the outside. This is also true in sketch *b*. That the above condition prevails is proven by the type of fracture shown in Fig. 2 as compared to the type of fracture shown in Fig. 1. In Fig. 2 the fracture occurred first in the three outer layers, while in Fig. 1 the fracture occurred suddenly with violence, and shattered the end of the vessel.

In each case the failure of the two layer vessel occurred without shattering and without throwing pieces of steel in the air, while in the three thick wall vessels, the fractured pieces acted in a manner similar to that of the parts of a high explosive shell under detonation conditions.

In the bursting of the two types of vessels, the hydraulic pressures were in the range of from 15,000 to 20,500 pounds per square inch. This represents in the water and steel at rupture of between one and two million foot pounds of energy when considering the volume of water and steel used in the test vessels.

In a thick wall vessel the stiffness of the structure is so great that resistance to deformation results in a vessel at failure with practically no change in dimensions. The diameter at failure was increased about from 0 to 2 percent only. In the laminated vessel, however, the diameters of the test vessels were increased about 15 percent and this in itself is an added desirable quality in that it gives warning of unusual conditions before failure occurs.

There is one disadvantage in the laminated vessel which should be pointed out. If such a vessel should be used in a manner requiring the transfer of heat from the outside to the inside during operation, the rate at which heat can be transferred from the outside of the vessel to the inside will be lower than when using a solid wall vessel. In all other cases, however, the laminated vessel will adjust itself with less serious effects to service operations than will the solid wall vessel.

Quite a number of these vessels have been built and some have been in continuous high pressure service for nearly five years. The record of these vessels is exceedingly good.

Boiler Work in British India

By Walter Buchler

There are a number of large modern boiler shops in British India; those maintained by the railways and by the firm of Tata which is perhaps the most important of all. Then, there are several shops belonging to large engineering firms in Bombay and Calcutta, more particularly in Calcutta.

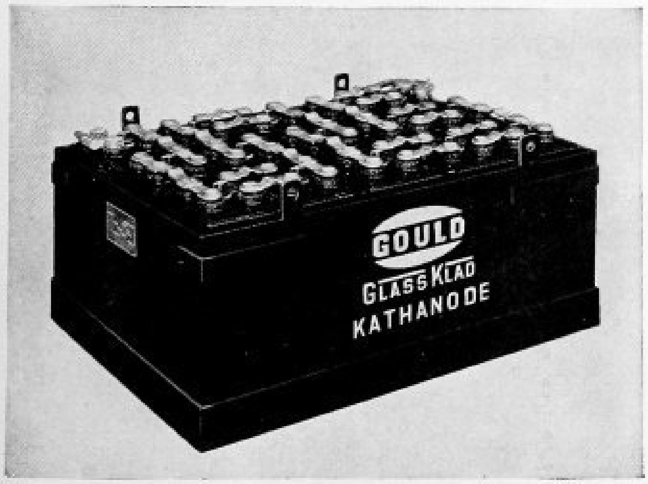
Indian boiler makers are called so as long as they have anything to do with boilers. Most of the locomotives come out ready built and new boilers are not constructed. An attempt was made some years ago to construct boilers, but by the time the plate was removed from the furnace and put on the bending machine, the heat was out of it due to the slowness of the Indian. Quickness is not one of his characteristics.

In the Indian railway shops there are three scales of boiler makers. The boiler inspectors are usually Europeans who have gone right through boiler construction and know their jobs thoroughly. Then there are what is known as the district boiler makers, whose duty it is to examine any boilers on locomotives in their district. This means that a man in this position may have three to five engine houses. All pump engine boilers also come under him. He may be a European, Anglo-Indian, and, of more recent times, perhaps an Indian, but whoever he is, only men of ability are selected for these jobs. Under the district boiler maker come mistris, joint makers, and coolies. The mistri's work is the renewing of stays, calking of firebox corners, foundation rings, or any other work coming under boiler or firebox repairs, while the coolies are used for carrying tools. No mistri (Indian master-craftsman) will work without having a coolie to carry his tools or to fetch any material he may require. Mistris get rupees 100 and upwards, up to rupees 250; a district boiler maker, rupees 350; a coolie, rupees 15, and an inspector rupees 550, with traveling allowances, these being monthly wages.

A lot of work that is done in the West by the boiler maker, in India comes under the fitters, merely because here they have a different system of working. For instance, a boiler maker in India does the boiler washing, renews any broken stays, and any other repairs required in the boiler. Any bent rods that require straightening out and any other heavy work of a similar nature are, however, given to the fitter to do, as this class of work falls within his department. Another example of this division of labor is to be seen in the following case: On engines fitted with an ash-pan drencher cock, if anything goes wrong with the cock, it is the fitter's job. If anything is wrong with the pipe, it is the boiler maker's work, though in Western countries both would be seen to by one man.

Motive Power Storage Battery

An improved type of battery, for use on locomotives, industrial trucks, highway trucks, etc., is now being offered by the Gould Storage Battery Corporation, Depew, N. Y. This battery, known as type KMD, is similar in form to the RVPX unit which it displaces, in that highly porous, laminated mats of spun glass are held against both sides of the positive plates to prevent loss of active material. These mats are now held in intimate contact with the plates by perforated, hard-rubber envelopes which are formed over plates and mats. The porosity of the rubber has been increased by a new arrangement of perforations. The ribbed wood separators, formerly used between positive and negative plates, have been replaced with Durapor separators. Durapor is a non-porous combination of silica gel with finely divided particles of rubber. It prevents bridging from positive to negative plates, but does not inhibit chemical action.

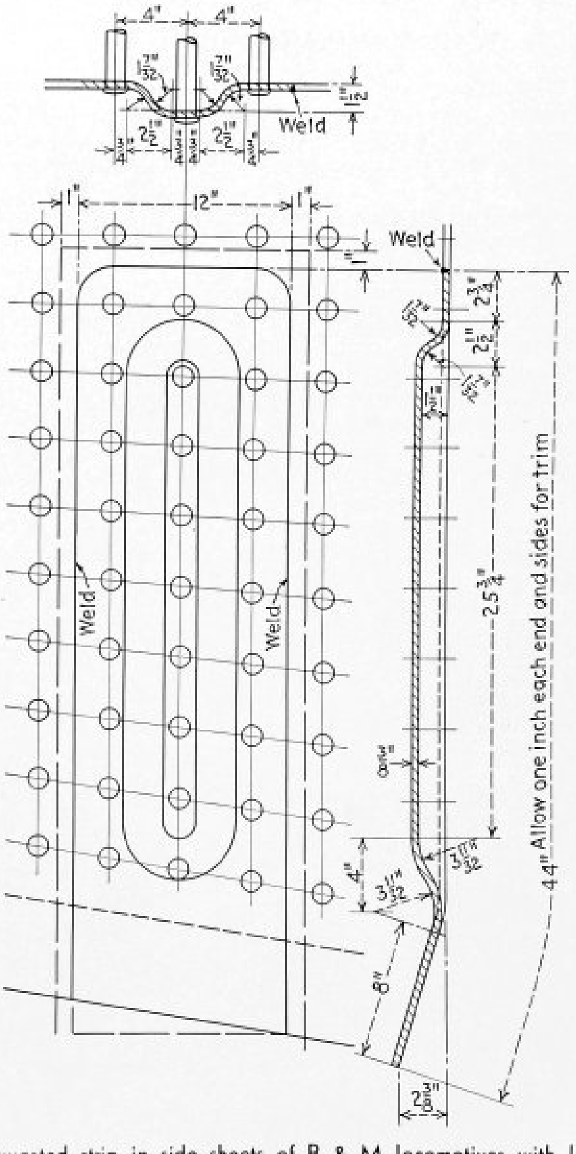


Improved Gould storage battery

The Kathanode type of construction has been found effective in reducing loss of active material, and the sediment space has been reduced from 1¾ to 1¼ inch, thus dropping the elements in the cell and providing for more electrolyte space at the top and better insulation. Other improvements include large vent plugs, having built-in baffles to prevent spraying of electrolyte, and refinements in tray structure, to meet the requirements of motive power service.

Corrugations Increase Life of Firebox Sheets

The greatest amount of expansion in a firebox comes at a location where the temperature is highest and increases with the length of the sheets. The point of maximum expansion is in the side sheets under the arch.



Corrugated strip in side sheets of B. & M. locomotives with large fireboxes

Here the horizontal length under the arch is more than three times the vertical height. The short life of such side sheets proves that the expansion here is beyond the fatigue limit of the steel. The Boston & Maine, in order to take care of this expansion in a 100-square-foot box without exceeding the elastic limit, a few years ago tried the experiment of pressing in the sheet three vertical corrugations, as shown in the sketch. These corrugated sides were installed on one side of locomotives Nos. 4013, 4014 and 4016, the regular flat sheets being retained on the other side. All of these corrugated sheets are still in service (one was removed for inspection and replaced) and have had approximately four years' service to date—one has passed 50 months. The flat sheets opposite have all been renewed once and some twice. From this experience it will be noted that the first three experimental installations have to date more than doubled the life of these locomotive side sheets.

These corrugations may be pressed singly and the patches then welded in the box if it is not convenient to press the side sheet itself. The only difference is one of relative cost.

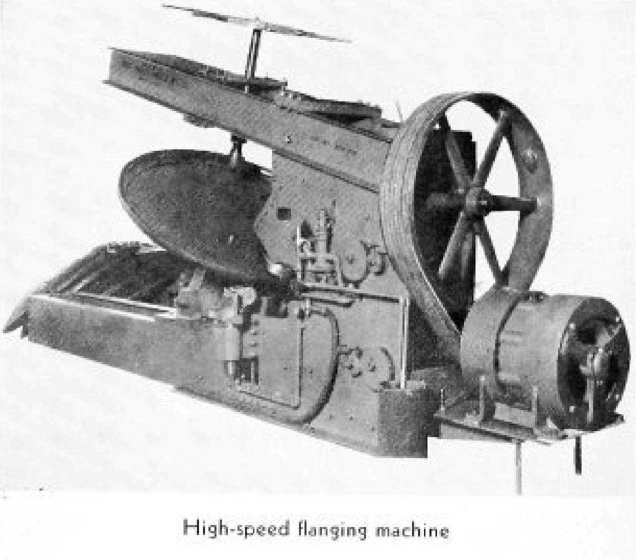
Flanging Machine Provides High Speed Operation

A new type of high-speed flanging machine for flanging boilers and tank heads, either flat, bilged, concave or round, is announced by the Blue Valley Machine and Manufacturing Company, Kansas City, Mo.

This flanging machine provides unusually high flanging speeds. Only one minute's time is said to be required for making a 2½-inch flange on a 12-foot diameter flat head ¼-inch thick.

Overall dimensions of the machine illustrated are 5 feet wide by 16 feet long by 6 feet high. Construction is characterized by simplicity and strength. The flanging mechanism is mounted on the main frame. All operations for flanging are performed through a centralized group of controls, located so that the operator has a clear view of the work at all times.

When the flange is completed, the working rolls and the center hold-down are backed off, releasing the work. Due to the arrangement of the rolls and controls, flanges are made without any signs of distortion or wrinkling in the finished head, despite high speed operation.



High-speed flanging machine

The rolls are made of high-grade tool steel. All revolving parts are equipped with roller or ball bearings. Power for operating the machine is supplied by a 15 horsepower Linc-Weld self-protecting motor, supplied by The Lincoln Electric Company, Cleveland.

The Blue Valley Machine and Manufacturing Company builds six sizes of flanging machines. These machines range in length from 10 feet to 16 feet, in width from 18 inches to 5 feet, and in height from 5 feet to 6 feet. Capacity of the machines is from 30 gage thickness, 12-inch diameter to ⅝-inch thickness and 20 feet diameter. The six machines are powered with ¾, 1½, 7½, 10 and 15 horsepower motors.

Mechanical Engineers Annual Meeting

Sessions on Psychology (Symposium on Effect on Human Relations of Technological Changes), Compensation Laws, Occupational Diseases (auspices A.S.M.E. Safety Committee), as well as the regular sessions of the Railroad, Fuels, Power, Applied Mechanics and other divisions of the American Society of Mechanical Engineers, will feature the 1935 annual meeting of the Society to be held at the Engineering Societies building, 29 West Thirty-Ninth street, New York, December 2 to 5, inclusive. The following papers of interest to members in the railroad industry as well as to the boiler industry will be presented:

Tuesday, December 3
9:30 a.m.

Measurement of Steam Rate and Indicated Horsepower of Locomotives, by Arthur Williams

Railroad Mechanical Engineering (Progress report)

2 p.m.

Locomotive and Car Journal Lubrication, by E. S. Pearce

Wednesday, December 4
(Locomotive Session)
2 p.m.

Lateral Oscillations of Rail Vehicles, by H. F. Langer and J. P. Shamberger

Safety of High-Speed Locomotives, by B. S. Cain

Among other sessions of general interest are the following:

Wednesday, December 4
2 p.m.
Boiler Furnace Session

An Experimental Investigation of Heat Absorption in Boiler Furnace, by W. J. Wholenberg, H. F. Mullikin, W. H. Armacost and C. W. Gordon

Critical Review of Methods of Computing Heat Absorption in Boiler Furnaces in the light of data presented in Part I, by W. J. Wohlenberg and H. F. Mullikin

An Empirical Method of Solving for Heat Absorption in Boiler Furnaces, by H. F. Mullikin

Thursday, December 5
2 p.m.
Boiler Feedwater Session

The Use of Solubility Data to Control the Deposition of Sodium Sulphate or Its Complex Salts in Boiler Water, by W. C. Schroeder, A. A. Berk and E. Partridge

Estimation of Dissolved Solids in Boiler Water by Density Readings, by J. A. H-lmes and J. K. Rummel

Suspended Solids in Foaming and Priming of Boiler Water, by C. W. Foulk

Effect of Solutions on Endurand of Low Carbon Steel Under Repeated Torsion at 482 deg. F. (250 deg. C.), by W. C. Schroeder and Everett P. Partridge

Embrittlement of Boiler Steel by Caustic Soda, by G. H. Wagner and J. R. Wall

Study of Effect of Concentrated Sodium Hydroxide on Boiler Steel Under Tension, by A. S. Perry

Radiation from Non-Luminous Flames, by H. C. Hottel and V. C. Smith

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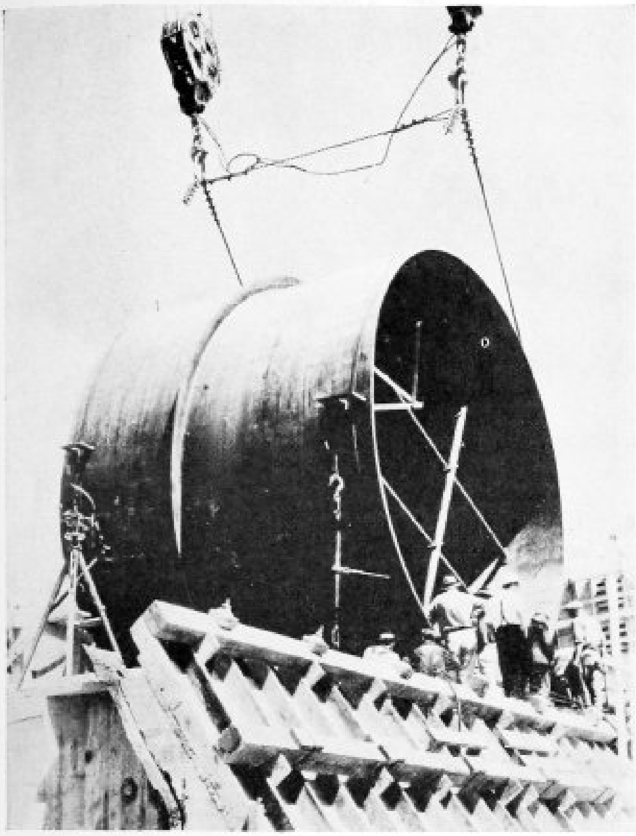
R. P. Kilsby, of the general sales office of the Babcock & Wilcox Tube Company, Beaver Falls, Pa., has been appointed manager of its western sales territory. Mr. Kilsby will have jurisdiction over all the districts covered by its offices located west of the Mississippi river and will have his headquarters at the company's Chicago office in the Marquette building.



Section of finished pipe in place

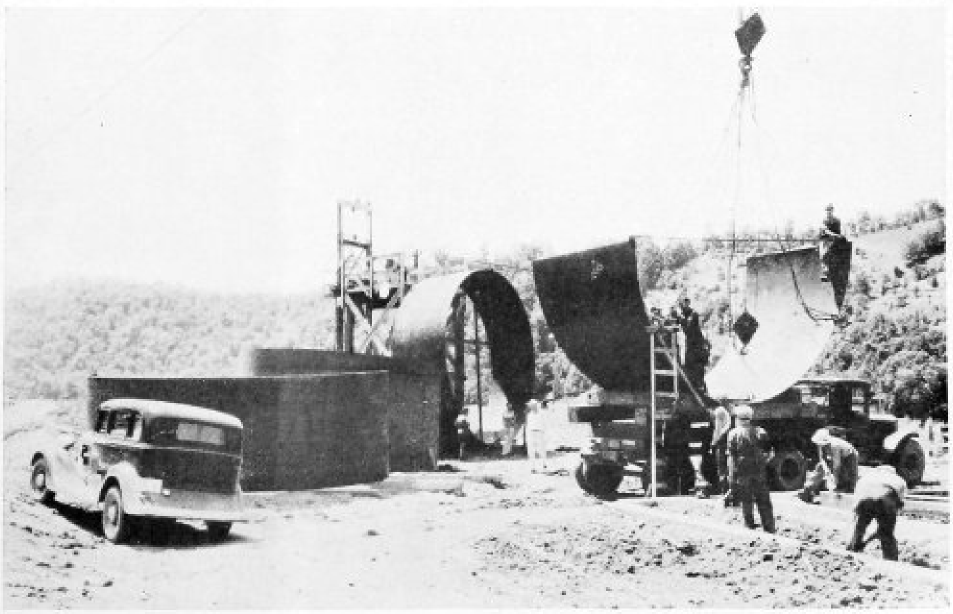
ALL-WELDED PENSTOCK

for Norris Dam

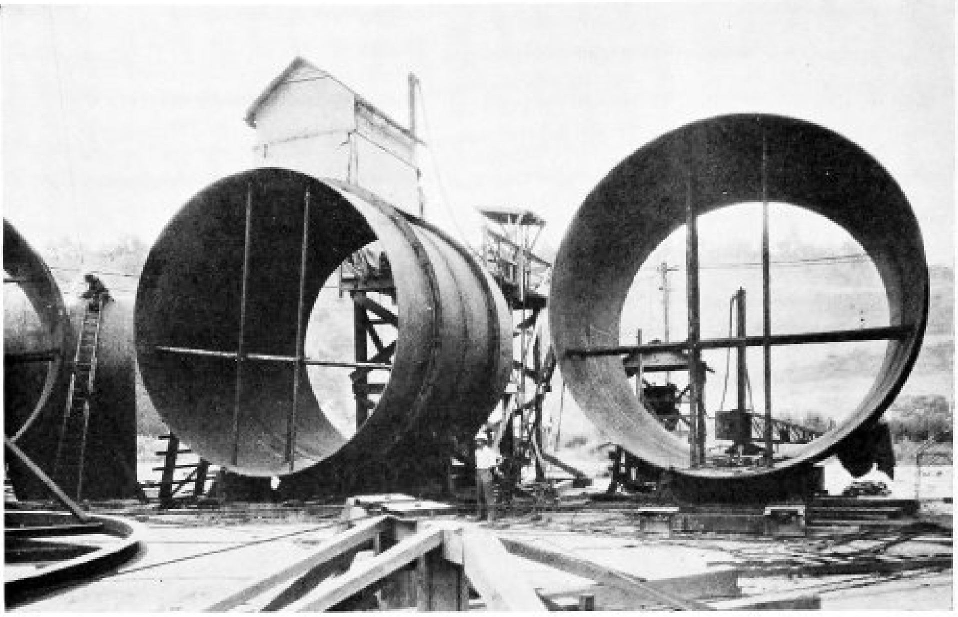
The Chicago Bridge and Iron Works recently completed the construction of two large penstocks for the Norris Dam of the Tennessee Valley Authority project. These steel penstocks are 20 feet in diameter, and vary in thickness from 1⅛ inches to 1⅛ inches. The Electronic Tornado system of welding was used for the part of the work which was automatically welded. This system utilizes a magnetically controlled carbon arc which, combined with the proper flux, gives weld metal of the quality required by A.S.M.E. Class 1 welding specifications under which the work was done. After sections of pipe had been fabricated by automatic welding, they were transported to their place in the dam and joined together by manual shielded arc welding.

Norris Dam, first of six in the huge TVA development, is located about 25 miles northwest of Knoxville, Tennessee. It will be 253 feet high from foundation to roadway, 210 feet thick at the base, and 1800 feet long at the crest. The waters impounded by Norris Dam will form an artificial lake of 3,600,000 acre-feet covering some 80 square miles with a shore line of more than 800 miles. The cost of the dam is estimated at about $34,000,000. Two 60,000-horsepower generating units will be installed in the power house.

Each of the two penstocks was built of plates formed in semi-cylindrical sections at the Birmingham plant of



Section of penstock shipped to Norris Dam in semi-cylindrical sections, which were welded together into 20-foot lengths 20 feet in diameter



At the field fabricating plant semi-cylindrical sections of pipe were fitted up on special forms and welded in 20-foot lengths

the Chicago Bridge and Iron Works and shipped to the site of the dam.

At a field fabricating plant four plates were welded together to form a section 20 feet in diameter by 20 feet long. The heaviest of these sections weighed approximately forty tons. The automatic welding at the field plant was carried out as follows: First, two plates forming a cylindrical section 20 feet in diameter 10 feet long were tack welded together in a special fitting up form. The seams joining these plates were then welded by the automatic welder. Two of these 10-foot sections were then tack welded together and placed on power driven rolls which turned the pipes for making the automatic circumferential weld. All automatic welds were of the double "U" type.

As a means of stiffening the penstock a steel ring $1\frac{7}{16}$ inches by 8 inches was welded around the outside of each 10-foot section.

After welding, all welded seams were X-rayed and all defects disclosed by the X-ray photographs were repaired. The welded joints were then stress relieved electrically. After being heated to proper temperature the welds were allowed to cool uniformly with the heating elements and insulating blankets in place. During heating and cooling, protection from the weather was provided by a temporary housing erected over the pipe.

Tests were made of the welded joints by cutting samples from test plates welded under identical conditions. The specifications for the work required an all weld metal sample to show a tensile strength of 55,000 pounds per square inch, ductility of 20 percent elongation in 2 inches and specific gravity of 7.80. Also, a free bend test was required to show 30 percent elongation in outside fibers without any indication of fracture or tear.

After approval by the inspector, each 20-foot section was hauled from the fabricating site on a heavy duty trailer and swung into position on the dam by overhead cableways. When properly placed, the sections were welded together by the manual shielded-arc process of welding. When all welding was completed the insides of the penstocks were sand blasted and given a coat of paint.

All welding was done by Chicago Bridge and Iron Works operators using automatic welding equipment, electrodes and manual welding machines supplied by The Lincoln Electric Company, Cleveland.

The two penstocks were built under the direction of O. A. Bailey, chief engineer of the Chicago Bridge and Iron Works, to which company should go considerable credit for completing the job on schedule.

Taps From the Old Chief's Hammer*

The old Chief, veteran inspector, and his assistant, Tom Preble, was returning to the office one noon.

"Tom," he said, "I want to stop a minute and get some more smoking tobacco."

"O.K.," Tom responded, "I'll wait here on the street."

He watched the older man walk up three well-worn steps into the lobby of a building and wondered how many times his superior had entered that building for his favorite brand of smoking tobacco—years and years, and once a week regularly.

Tom got to musing over those three steps into the building. How worn they were! How many persons must have passed that way to hollow out the stone like that! When the chief came back, Preble mentioned the steps.

"Yes," his superior remarked, "I've probably helped some. I've been going up and down those steps for 15 years and longer. Speaking of wear, though, those steps remind me of a nice piece of work Inspector Honnecker carried out at the G. B. W. Paper Mill back in 1925. Have I told you about it?"

"I don't think so, Chief," Preble said, and as they walked along the older man unwound another story from his wide experience with pressure vessels.

"I told you those worn steps brought this story to mind," he began, "but anybody can see that those stair treads are thin. They're scooped out in the center and flat at the ends. Discovering thinness in a pressure vessel isn't so easy.

"Honnecker feared that seven digesters which he in-

* From *The Locomotive*, published by the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

spected were worn, but proving conclusively that he was right was another matter. His suspicions were aroused by his experience with various kinds of pressure vessels. For some reason the situation brought to mind a worn rendering tank he had seen back in Detroit. Over a 10-year period the metal on that vessel had gradually been reduced in thickness until it was dangerously thin, and yet neither the outside nor the inside gave any visible clue. The outside looked much the same as it always had and the inside was smooth and apparently in good condition. What had occurred was a uniform wear which could be detected only by boring test holes.

"The digesters Honnecker was so worried about were of a fair size. As I remember it, 9 feet in diameter and about 30 feet high, and a vessel that large at the 125 pounds pressure carried can cause an accident of major proportions, as you very well know.

"Honnecker went over those digesters with a fine tooth comb every time they came up for inspection. He reported pitting along the so-called liquor line, but could detect no appreciable wear. The plates presented a practically smooth, even surface.

"I didn't like those 25-year-old digesters any better than Honnecker did, so between us we succeeded in getting the owners to consent to the drilling of test holes. The owners had been reluctant to make such tests because they had had trouble in keeping the openings tight.

"On the next inspection three men were placed at Honnecker's disposal. The plan was to fill the vessel with chips, a little at a time, so that the men who were doing the drilling would have something to stand on and thus eliminate the necessity of building a scaffold.

"Just as the chips were about to be put in the digester, Honnecker got an inspiration. He wondered what path the chips took as they entered the vessel.

"'Hey, you fellows,' he called, 'I want to watch those chips as they come in, wait until I get inside.'

"The helpers thought he was getting himself into an unnecessary mess, but 'it was his funeral' they said, and Honnecker climbed into the digester.

"He noticed, as the chips were admitted, that they struck on one side and slid down to the bottom. He reasoned that if the plate was worn anywhere it most certainly would be on the side where the chips struck.

"So he directed that the drilling be concentrated in this area. The result was the discovery that the plate had been reduced from its normal thickness of three quarters of an inch to an average of about half that over an area 20 feet high and 8 feet wide.

"The plates then gradually thickened up on each side of this area until the wear on the opposite side of the digester was negligible.

"The owners were notified and this digester was removed from service."

Preble interrupted, "What about the other six digesters, Chief?"

"Coming to that, boy," the veteran replied. "Of course, the other six were drilled. All of them had become dangerously thin. Some of them were even worse than the first vessel.

"The plant owners were pretty worried, for other digesters they had wouldn't supply anywhere near the demand. So the digesters were operated at a reduced pressure and one by one they were replaced with new and safe vessels.

"Then everybody concerned heaved a sigh of relief, I can tell you.

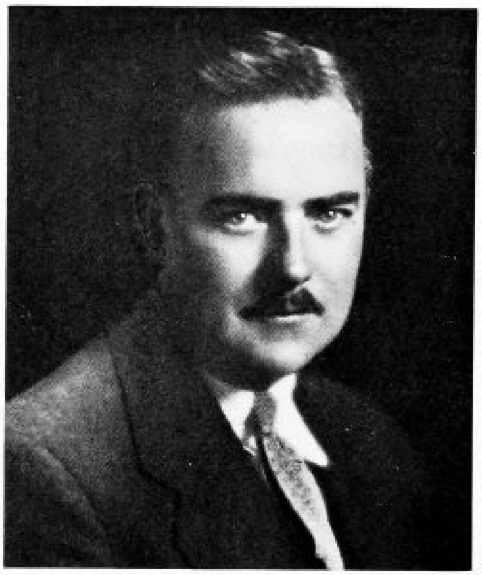
"Well, here we are back at the office and some more worn steps, and Tom, I expect to see those stairs worn down considerably before I'm done with them."

"So do I, Chief," said Tom.

New President of Champion Rivet

Announcement was recently made of the election of T. Pierre Champion to the presidency of the Champion Rivet Company, Cleveland, one of the largest rivet manufacturing concerns in the world.

Pierre Champion, who, since 1928 has been vice-president in charge of sales, succeeds his late father, David J. Champion, founder of the company, who died September 10 at the age of seventy-four. The company was founded in 1895. The company now has factories in Cleveland and East Chicago, Ind. The new president is thirty-six years old. He was graduated from the University of Notre Dame in 1922. He immediately took a position with the Champion Rivet Company and for two years was employed in the plant making rivets, thus learning the business from the ground up.



T. Pierre Champion

In 1931 the company decided to expand the scope of its service to the metal fabricating industry, and accordingly developed the necessary groundwork to place before the trade a complete line of coated welding electrodes. Pierre Champion was in direct charge of this development and today the manufacturing of welding electrodes is a very important part of the Champion Rivet Company's business. In fact, this is the only manufacturer of rivets including welding electrodes in its line of products, thus recognizing the importance of welding in the field of modern fabricating methods.

Mr. Champion was very closely associated with his father in the management of the business for a period of ten years. There will be no change, he states, in the policies of the company.

Changes in Steel and Tube Personnel

Due to increased business activity in the territory normally served from Philadelphia, Steel and Tubes, Inc., has recently created a new sales district in order that more concentrated attention can be given to customers in that territory. The new sales district, headed by C. J. Boyd, formerly of the Brooklyn, N. Y., sales organization, as district manager, will consist of the states of North and South Carolina, Virginia, Maryland, Delaware, southern New Jersey, including Trenton; also southeastern Pennsylvania.

Part of the new sales district was formerly included in the New York sales district and part in the Birmingham sales district. Several other changes in the sales organization were also made.

J. F. Keeler, formerly of the Sales Promotion Department in Cleveland, has been transferred to the Brooklyn office to head the sales promotion work in the east; I. H. Anderson, formerly of the Philadelphia office, has been transferred to the Brooklyn office; and J. S. Anderson, formerly of the Detroit office, has been transferred to the new Philadelphia office.

J. D. Benfield and Robert Turrell, formerly with the Electrical Division of Steel and Tubes, Inc., have formed their own organization, known as Turrell & Benfield, Inc., with headquarters at Detroit, and are representing Electrunite Steeltubes and Fretz-Moon conduit products in the Michigan territory.

President of Shepard Corporation Dies

Frank A. Hatch, president of Shepard Niles Crane & Hoist Corporation, Montour Falls, N. Y., died at his home in Montour Falls on October 15. Mr. Hatch was born in November, 1877, at Bay City, Mich., and was graduated from the University of Michigan in 1900. Three years later he served as treasurer of the Pneumatic Tool Company at Montour Falls, in 1917 becoming vice-president and general manager of its successor, the Shepard Electric Crane & Hoist Company. In 1929 he was elected president and a member of the executive committee of the Shepard Niles Crane & Hoist Corporation. He was also a director of the Niles-Bement-Pond Company, New York.

Plans for Heating and Ventilating Exposition Being Completed

Enthusiastic support, reflecting improved business confidence, is evident now three months in advance of the opening of the Fourth International Heating and Ventilating Exposition to be held at Chicago during the week of January 27 to 31, 1936. The International Amphitheatre in which it will be presented is one of the most modern and ample settings in which this air conditioning exposition has yet appeared. Previous expositions have been held in Philadelphia, Cleveland, and New York.

Furnaces and boilers of every type and for every fuel will be on display, and there will be a comprehensive showing of unit heaters and central heating systems. Hot water heaters, both separate and for use in conjunction with main heating plants will be demonstrated with emphasis on speed and economy of operation. Every form of air conditioning with accessories will be shown in a large section of the exposition devoted to this new field. There will also be many exhibits devoted to refrigeration and to the display of insulation materials protective against heat and cold. The ventilating section will cover all phases of the equipment problem from intake to distribution, showing a comprehensive pageant of fans, blowers, registers, grilles, and air filtering materials.

Oil-fired automatic boilers will be the subject of several exhibits and some will be so designed that the oil burner can be completely enclosed within the jacket without increasing the size of the unit. Boilers will be equipped with domestic hot water supply coils to provide this very necessary service without a storage tank.

Ira H. Pool Joins National Tube Field Service Staff

Ira H. Pool has resigned his position as district boiler inspector with the Baltimore and Ohio Railroad, to join the field service staff of the National Tube Company, Pittsburgh. Mr. Pool is widely known throughout the railway boiler industry through his activities in the affairs of the Master Boiler Makers' Association of which he is now second vice-president.

Ira H. Pool

After attending school in Minneapolis, Minn., and the University of Valparaiso, Ind., he began his railroad career as an apprentice in the Minneapolis and Deer Lodge, Montana, shops of the Chicago, Milwaukee and St. Paul Railroad. From 1914 to 1919 he served as boiler maker foreman of the Erie Railroad Company at Marion, O., and Galion, O. On April 1, 1919, he joined the Baltimore and Ohio Railroad as district boiler inspector of the Maryland and West Virginia districts, in which capacity he served until his resignation on November 1, 1935.

Dr. Partridge Becomes Director of Research of Hall Laboratories

J. M. Hopwood, president of the Hagan Corporation, Pittsburgh, Pa., has announced the appointment of Dr. Everett P. Partridge as director of research of Hall Laboratories, Inc. In this position, which he assumed September 1, Dr. Partridge will be associated with Dr. Ralph E. Hall, the managing director of Hall Laboratories and his staff, with the scientific and technical specialists of Hagan Corporation, The Buromin Company, and Calgon, Inc., all of which are allied organizations, and also with the incumbents of the Industrial Fellowship on Calgonizing sustained by Calgon, Inc., at the Mellon Institute of Industrial Research.

Dr. Partridge has distinguished himself during the past ten years by his researches on boiler water problems. On completing his undergraduate course in chemical engineering at Syracuse University in 1925, he transferred to the University of Michigan, where—as Detroit Edison Fellow in chemical engineering under the direction of Professor Alfred H. White—he investigated the acid-treatment of zeolite-softened bicarbonate waters and the fundamental mechanism of boiler scale formation, receiving the degrees of M.S.E. in 1926 and Ph.D. in 1928. At the conclusion of his graduate studies he was appointed associate editor of *Industrial and Engineering Chemistry.*

While specializing in the study and reporting of industrial operations for this periodical, he also served on a part-time basis as research engineer of the Department of Engineering Research of the University of Michigan in connection with further studies of scale prevention, and prepared a monograph on the "Formation and Properties of Boiler Scale," which appeared in 1930 as bulletin 15 of this department.

In the spring of 1931 he was appointed supervising engineer of the Non-metallic Minerals Experiment Station of the U. S. Bureau of Mines, maintained in cooperation with Rutgers University at New Brunswick, N. J.

Dr. Partridge returned to active research on boiler water problems in 1933 as a result of a movement initiated by Hall Laboratories and later taken up by the Joint Research Committee for Boiler Feed Water Studies, as a co-operative investigation by the American Society of Mechanical Engineers and the U. S. Bureau of Mines. This investigation is proceeding at the present time.

New District Sales Manager for Republic

George E. Clifford has been appointed district sales manager of Republic Steel Corporation in the Los Angeles, Cal., District, according to an announcement by N. J. Clarke, vice-president in charge of sales for Republic. Mr. Clifford was appointed following the resignation of George F. Emanuels who has been in charge of Republic's Los Angeles office for several years. Mr. Clifford attended the University of Pittsburgh, class of 1918, but left college in 1917 to join the Royal Flying Corps. He received his discharge from the Corps in December, 1918. From February, 1919, until 1925 he was connected with the sales department of the Atlas Powder Company, at Pittsburgh, Pa. He then became district representative in Cincinnati, O., for the A. M. Byers Company. Two years later he was made manager of the Central District for Byers and afterwards was made manager of their Pittsburgh District. Mr. Clifford joined Republic Steel Corporation in August, 1930, as assistant manager of sales in the Pipe Division.

Bethlehem Issues Steel Handbook

A 362-page ready-reference handbook, for designers, fabricators, engineers and consumers of steel plates and flanged-plate products has recently been published by Bethlehem Steel Company, Bethlehem, Pa. In it the subject matter is technically though simply treated, from details of manufacture in a word and picture story to the various applications of these products in tanks, stills, pressure vessels, cars, locomotives, ships, barges, boilers, buildings, bridges, etc., and many special applications.

The primary purpose of this thoroughly modern handbook is to provide, in one complete volume, all the necessary working data, such as tables, specifications, general engineering and metallurgical information, helpful to designers, fabricators, and other users of steel plates, flanged-plate products and tubes.

Under each of its five main divisions is correlated all the pertinent data thereto, making it unnecessary to refer to other sources for specific information: Part I is concerned with manufacture, specifications, tabulated data and applications; Part II covers flanged and dished heads; Part III deals with tubes; Part IV takes up boiler design, riveted joints, welding, etc.; Part V includes indispensable engineering tables, such as functions of numbers, natural trigonometric functions and so on. And for convenient recording of data for future reference blank cross-section sheets are inserted next to the index.

This copyrighted volume is made up in fabrikoid covers, 6½ inches by 9¼ inches, with title and trade-mark lettering stamped in gold. Price, $1.00.

Record Trip for Trailer Type Welder

The most sought-for qualities in an arc welding machine are its dependability and durability. The machine illustrated, a Wilson gas engine-driven 300-ampere arc welder mounted on a rubber tired truck trailer has run up an enviable record for both in its three months' jaunt around the country, in which it covered all the Airco Districts east of the Rockies except Minneapolis. It was towed 10,000 miles over every kind of road imaginable—concrete, dirt, bad detours and mud. Some of the roads were so bad that the highest speed possible was six to eight miles an hour. The elements as well as the roads imposed a terrific test on the machine. Rain for a week at a time—snow, sleet, dust storms and temperatures that varied from 86 degrees to 4 degrees below zero.

The traveling welding exhibit

As to its working characteristics, the machine was exhibited at 65 different shows, in charge of fourteen different men. At each show from 50 to 150 men used the machine with every type of rod carried by the Air Reduction Sales Company, and practically every man changed voltage and amperage in rapid succession.

Fred J. Maurer, Director of the Airco Welding and Cutting Show now heading for the West Coast for another series of shows, says, "the machine has taken a terrible beating on this trip, and I want to say that it is now and has always been in perfect operating condition. Since we left on this tour, the only expense we have had was for gasoline and oil. *We have not spent one cent for maintenance repairs.*"

The Miller Steel Company, Inc., Newark, N. J., has been appointed warehouse distributor of mechanical seamless steel tubing for the Globe Steel Tubes Company, Milwaukee, Wis.

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

VOLUME XXXV NUMBER 11

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Request for change of address should reach us on or before the 15th of the month preceding the issue with which it is to go into effect. It is difficult and often impossible, to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address, please be sure to send us your old address as well as the new one.

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EDITORIAL STAFF: H. H. Brown, Editor. L. S. Blodgett, Managing Editor
BUSINESS MANAGER: Warner Lumbard.

Contents

Trade Publications

STEEL PIPING.—A folder entitled "The Greatest Pipe Show on Earth," has recently been issued by the Republic Steel Corporation, Massillon, O., which describes the various types of tubular products manufactured by Republic and its subsidiary, Steel & Tubes, Inc. The index of this folder is a special feature which makes it most convenient for use.

ALLOY STEEL SHEETS.—Two illustrated folders describing corrosion resisting qualities of Beth-Cu-Loy sheets have been issued by the Bethlehem Steel Company, Bethlehem, Pa. These folders describe tests carried out on sample sheets of this material in a concentrated industrial area at Brunot Island, Pittsburgh; in salt air at Key West, Fla.; and at other points under more normal atmospheric conditions.

REFRACTORIES.—A pamphlet entitled "A New Application of The Ritex Process to the Manufacture of Chrome Brick," written by R. P. Heuer, director of research, General Refractories Company, Philadelphia, Pa., has recently been issued.

HANCOCK VALVES.—The Hancock Valve Division of Consolidated Ashcroft Hancock Company, Inc., Bridgeport, Conn., has issued two bulletins, the first describing Hancock Flocontrol valves. This is the first manually operated valve with a straight-line flow characteristic. The second bulletin gives details of the new Hancock union bonnet bronze valve. A special feature of this valve is the superhard stainless steel trim which is claimed to be resistant to steam cutting and wire drawing throughout its long life.

DUO METALS.—The Latrobe Electric Steel Company, New York, manufacturers of electric furnace steels, has issued a pamphlet dealing with Duo metals, which is a form of cladding by an entirely new system. By this process all of the high alloy steels that are capable of being forged can be welded to a low alloy steel or mild steel backing or any alloy steel. The details of the process and the wide range of products available are discussed at length in this bulletin.

WELDING ELECTRODES.—A 30-page catalogue bearing the title "Welding Electrodes by Wilson," has been issued by Wilson Welding & Metals Company, Inc., North Bergen, N. J. The catalogue includes tables showing chemical analysis of electrodes, electrode numbers and applications, arc voltage, amperes recommended for various diameter electrodes, size and weight of electrodes and amount of deposited metal. The catalogue is featured by a number of illustrations, showing difficult arc-welding operations with explanatory details.

SEAMLESS PIPE FITTINGS.—The Taylor Forge & Pipe Works, Chicago, Ill., has distributed a folder calling attention to the advantages of seamless steel welding fittings. Taylor Weldells are selectively reinforced. No wall is less than pipe thickness and the crotch—the region subjected to the greatest strain—is reinforced in proportion to the added strain that it must stand as brought out by tests and formulae for bursting stresses. In the design of Weldells, tees, nipples, caps, and flanges, Taylor Forge has adhered strictly to engineering principles.

UNIVERSAL ELECTRIC TOOLS.—The Independent Pneumatic Tool Company, Chicago, Ill., has issued a catalogue which illustrates and presents specifications on the entire Thor line of universal electric tools. The catalogue includes the new U-14, smallest and lightest weight portable electric tool ever built. It is half the size of other similar tools of the same capacity but develops exactly the same power. A complete showing of portable drills, screw drivers, hand grinders, bench grinders, nut setters, tappers, saws, and electric hammers is included.

ARC WELDING.—"Automatic Arc Welding by the Electronic Tornado" is the title of a 42-page book just announced by The Lincoln Electric Company, Cleveland. A full explanation of the electronic tornado system of automatic carbon arc welding, developed by Lincoln for use in industries where products of relatively uniform character are produced in large quantities. Included in the text are explanations of how the heat of the carbon arc is concentrated by the electronic tornado; how the carbon arc is shielded in automatic arc welding; physical properties of electronic tornado welds; how this process simplifies automatic arc welding, etc. Various types of welds suitable for automatic welding are illustrated.

Questions and Answers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Steam Jacketed Kettle Design

Q.—Will you kindly furnish us with formulas for calculating the thickness of material, size and spacing of staybolts for steam jacketed cylindrical kettles. J. P. C.

A.—A complete set of formulas for computing the thickness of material, size and spacing of staybolts for steam jacketed cylindrical kettles would require more space than is allotted to this department. Same can be obtained by securing a copy of the A.S.M.E. Code, Sections I and VIII, from the American Society of Mechanical Engineers, 29 West 39th Street, New York.

Should any question arise as to the application of these formulas to your particular problem, I would be glad to assist you.

Books on Laying Out Work

Q.—I am a teacher of boiler maker students at the Crewe Technical College, England, and anxious to obtain the most up-to-date books dealing with this subject. I was wondering if you could recommend to me a few good books. I would especially like one that deals with intricate development problems. W. W.

A.—"Laying Out for Boiler Makers," fourth edition, published by the Simmons-Boardman Publishing Company, is a practical book on laying-out and developing all types of plate work, including elementary as well as more intricate problems. The development of the plates of a tubular, Scotch and locomotive boiler is given in a practical and up to date manner.

A practical boiler book is "The Design of Steam Boilers and Pressure Vessels" by George B. Haven and George W. Swett, published by John Wiley & Sons, Inc., New York City or Chapman and Hall, London, England; also "A Study of the Locomotive Boiler," by Sanford H. Fry, published by the Simmons-Boardman Publishing Company.

Efficiency of Riveted Seam

Q.—Fig. 1 is intended to show two designs of a boiler patch. One has a rivet at *A*, with a straight edge of the liner, and no rivet at *B*. The other has a rivet at *B* and none at *A*, the edge of the liner being shaped to include the rivet *B*. Giving attention only to the efficiency of the riveting outside the patch, but in the liner, is it allowable in computing the resistance to tearing through the rivet hole *B*, to consider that tearing will take place on the line *GH*? Is not tearing more likely to take place on the line *E-B-F*? And is not the slight gain in the length of plate to resist tearing, by placing the intermediate rivet at *B* instead of *A*, more than offset by the distortion of the liner due to the absence of any rivet between *B* and *J* and to the consequent indeterminate distribution of the load among the rivets, and to the introduction of tensile stress in rivet *B*, due to its angularity? Is *A* or *B* the preferable location of the intermediate rivet? G. F. S.

A.—The A.S.M.E. Boiler Code states that the efficiency of a joint is the relation which the strength of the joint bears to the strength of the solid plate. In case of a riveted joint this is determined by calculating the breaking strength of a unit section of the joint, considering each possible mode of failure separately and dividing the lowest result by the breaking strength of the solid plate of a length equal to that section considered.

Consider the case of the patch given in the question, as illustrated in Fig. I.

The distance *E-F* can be taken as a unit section. The efficiency should be computed for each possible mode of failure in order to determine the least efficiency of the patch, which in this case would be along the line *G-H* for a distance *E-F*, with a deduction of one rivet hole, then along the line *C-D* for a distance *E-F* with a deduction of two rivet holes plus the rivet *B* in single shear; then along the line *E-B-F* with a deduction of two rivet holes, plus the effect of the angular spacing of the rivets. Continue until all possible modes of failure have been computed and the least efficiency obtained.

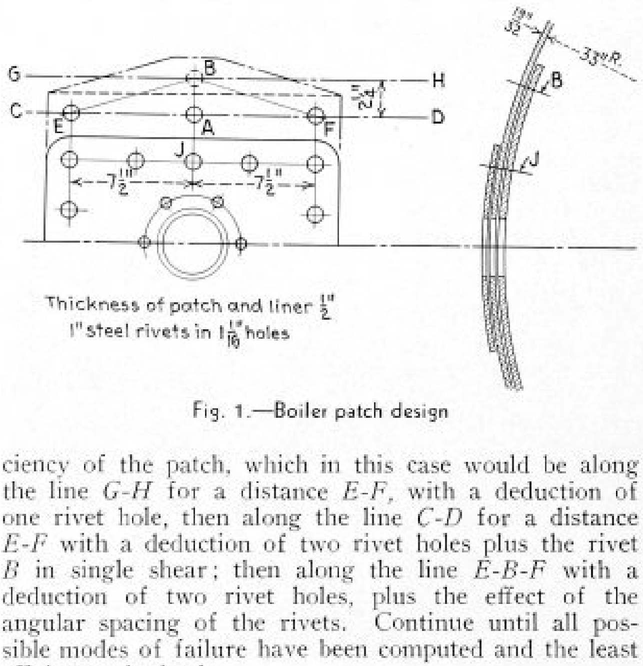


Fig. 1.—Boiler patch design

With reference to the tearing taking place along the line *E-B-F*, the Massachusettes Institute of Technology conducted a test some time ago to determine the liability of tearing along diagonal lines in riveted joints. A series of joints were designed and tested where the sum of the diagonal pitches as *E-B* and *B-F*, Fig. 1, bore a small but increasing ratio to the value of the longitudinal pitch as *E-F*, Fig. 1.

It was found by these experiments that if there was 10 or 15 percent excess tearing area on the oblique lines *E-B* and *B-F*, Fig. 1, that the joint would practically always tear on line *E-F*, Fig. 1.

In the patch shown in Fig. 1, the sheet would tear along the lines *E-B-F*, as there is, in this case, but a very slight increase in tearing area along the line *E-B-F* as against the line *E-F*. The lowest efficiency would be obtained along the lines *E-B-F*. However, I would place the intermediate rivet at *A* instead of *B* for the reasons as stated in the question, together with the fact that spacing the rivet at *B* increases the size of the patch with but little gain in efficiency.

Applying Staybolts — Tate Flexible Sleeves

Q.—I am writing you a few lines for information on applying Tate sleeves in locomotive boilers and I would like to know if there is a rule on how to apply them on the radius of a boiler. I would like to obtain a catalogue, if you can send me one on locomotive work. F. V.

A.—The following instructions apply to the application of Tate flexible staybolts sleeves.

1. In applying flexible staybolts covering large areas it is advisable to gag the sheets or hold them together, by screwing a stud through the tapped holes, locating such every four or five rows, and so spaced to prevent the springing in or out of the sheets when being machined or when bolts are being riveted over.

2. The most essential feature to keep in mind in order to effect a perfect installation of the Tate flexible staybolt, is the operation of machining the outer plate of the boiler for the fitting of the Tate sleeves. There should be no trouble whatever in making a good tight sleeve fit in boiler plate. Each hole drilled and taper reamed should be as round as possible and so preserved under process of tapping; and taps should be well oiled and in good order to insure good full threads as far as possible. Do not use taps with threads that are worn down, as such have a tendency to tear the metal. It is recommended that two or three taps be used at an operation, one in use while the others are cooling off in an oil bucket, well lubricated and ready for use.

3. Taps and reamers should be kept sharp, and the instant tap threads become rounded, they should be dispensed with, until reground or replaced, for perfect threads can only be maintained by keeping the taps ground sharp on the cutting face of the flutes. As a tap starts to break or wear down on the cutting edges of threads, the threads soon change their form accordingly and a good sleeve fit is impossible.

4. Depth of reaming and tapping should be carefully gaged to the proper size hole, to suit the right dimensions of the sleeve used.

A small section of boiler plate should be drilled, reamed and tapped to gage, so that a sleeve when screwed in tight comes flush with the inner surface of the plate, and with holes drilled, reamed and tapped respectively, in that same plate, this specimen of tooled plate will readily serve as a reference to set gages for the reamer and tap for the sleeve used.

5. If a tap follows an oval hole, the tendency would be to wabble the tap to fill the threads. Thereby a condition is produced which is most difficult to correct without recourse to calking to obtain a steamtight fit when the Tate sleeve is installed. If a wabbling tapping operation follows a round reamed hole, a like condition is presented. The plate should not be calked to obtain a tight sleeve fit.

6. An oval reamed hole is due largely to the weight of the pneumatic drill or machine drill, bearing down when held in position by the operators. These machines should be counterweighted by a rope or chain suspended above, or the machines supported in fixed position by the use of adjustable framework, ofttimes used in boiler shops to facilitate the drilling of outer side sheets of boilers.

Leakage is quite often traced to the foregoing factors during shop operation not being fully comprehended and practised, while if all matters as mentioned are followed carefully all difficulties will be overcome.

With a machine drill well supported, and good reamers and taps well oiled, secured to stiff guide bars to effect an alinement and help stiffen the tools, no difficulty whatever should be experienced in making a round taper hole with full threads.

It is essential that stiff guide bars be used and fitted perfectly to taps and reamers.

7. If high speed machines are used, high speed tools should be used, but do not use too fast a machine when reaming and tapping boiler plate material. Moderate speed machines geared for power, will render quicker and safer results, all things considered, than high speed machines which stall when forced.

8. After holes are tapped, detach the thin burr left by the tap on the face of the plate surrounding the hole; clean out the hole, and brush the sleeve threads with graphite mixed thin in good cylinder oil; screw in the sleeve with a 3-foot wrench, until tightness of screwing determines a joint.

9. The taper end of all Tate sleeves are $\frac{3}{4}$ inch to the foot—12 threads. According to this taper, there is a difference of $\frac{1}{16}$ inch in every 1 inch diameter, or $\frac{1}{64}$ inch to each $\frac{1}{4}$ inch of diameter. The 12-pitch thread is equal to 0.0833 inch for a full term.

10. A good sleeve fit is recommended under all conditions and the closer the tooling operation conforms to the sleeve, the better the fit. The use of white lead or other lubricants in sleeve threads to serve the purpose of making a good steamtight fit is left to the discretion of the operator.

11. Do not use the staybolt cap for screwing sleeves into the plate. The stud nut is more suitable and should be used.

12. Tapping the inner sheet in perfect alinement with hole of the outer sheet is essential to the proper assemblage of the bolt. If the threading of the inner sheet is done after the sleeve has been applied to the outer sheet, use a bush over sleeve to support the staybolt tap and prevent the threads from cutting the sleeves.

13. It is customary in many railroad shops to tap both sheets as for the rigid bolt, and then enlarge the hole in the outer plate and ream and tap to fit the sleeves, turning down the guide bars to fit the bottom of the threads in the inner sheet.

14. The face of the sleeves where the cap screws down and makes a joint, should be protected from burrs, jams, etc., throughout shop handling and riveting up of the bolt.

15. In drilling and tapping wrapper or roof sheets for radial sleeves, a good tooling operation is essential, using stiff guide bars for reamers and taps, and obtaining full threads in the plate at the angle used.

A catalogue of Tate staybolts can be obtained from the Flannery Bolt Company, Bridgeville, Pa.

New Sulzer Boiler Patent

An improved construction is disclosed in a new patent specification for boilers taken out in London by Sulzer Freres S.A. The patent covers a boiler of the type in which a combustion chamber is surrounded by a water jacket and includes a number of flat containers through which water passes to the water jacket and so to the central heating or other installation for which the boilers are used.

The usual direct connection of the inner flat containers to the water jacket by welding is undesirable on account of the strains set up on the welds due to temperature differences on intermittent firing. The new construction separates the jacket from the containers but brings the two water circuits together against some point in the pipe system where undue strains do not arise. Alternatively the two water supplied may be used for different purposes.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—John M. Hall, Washington, D. C.
Assistant Chief Inspector—J. A. Shirley, Washington.
Assistant Chief Inspector—J. B. Brown, Washington.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Director—Joseph B. Weaver, Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—D. S. Jacobus, New York.
Acting Secretary—M. Jurist, 29 W. 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—William H. Furman, Albany, N. Y.
Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.
Vice-Chairman—F. A. Page, San Francisco, Cal.
Statistician—L. C. Peal, Nashville, Tenn.

International Brotherhood of Boiler Makers, Welders, Iron Ship Builders and Helpers of America

International President—J. A. Franklin, Suite 522, Brotherhood Block, Kansas City, Kansas.
Assistant International President—J. N. Davis, Suite 522, Brotherhood Block, Kansas City, Kansas.
International Secretary-Treasurer—Chas. F. Scott, Suite 506, Brotherhood Block, Kansas City, Kansas.
Editor-Manager of Journal—L. A. Freeman, Suite 524, Brotherhood Block, Kansas City, Kansas.
International Vice-Presidents—Joseph Reed, 3753 S. E. Madison Street, Portland, Ore.; W. A. Calvin, Room 402, A. F. of L. Building, Washington, D. C.; Harry Nicholas, 6215 S. Benton Blvd., Kansas City, Mo.; W. E. Walter, 637 N. 25th Street, East St. Louis, Ill.; J. H. Gutridge, 2178 South 79th Street, W. Allis, Wis.; W. G. Pendergast, 1814 Eighth Avenue, Brooklyn, N. Y.; W. J. Coyle, 424 Third Avenue, Verdun, Montreal, Quebec, Can.; A. M. Milligan, 262 Trent Avenue, East Kildonan, Man., Can.; J. F. Schmitt, 28 S. Roys Street, Columbus, Ohio; William Williams, 1615 S. E. 27th Avenue, Portland, Ore.

Master Boiler Makers' Association

President: O. H. Kurlfinke, boiler engineer, Southern Pacific Company, 65 Market Street, San Francisco.
First Vice-President: Franklin T. Litz, foreman boiler maker, C. M. St. P. & P. R. R., Dubuque, Ia.
Second Vice-President: Ira J. Pool, field service representative, National Tube Company, 5610 Merville Avenue, Baltimore, Md.
Third Vice-President: L. E. Hart, foreman boiler maker, Atlantic Coast Line, Rocky Mount, N. C.
Fourth Vice-President: William N. Moore, general boiler foreman, Pere Marquette R. R., 625 College Avenue, S. E., Grand Rapids, Mich.
Fifth Vice-President: Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis (Big Four), 814 Big Four Building, Indianapolis, Ind.
Secretary: Albert F. Stiglmeier, general foreman boiler maker, New York Central, West Albany Shops, 29 Parkwood Street, Albany, N. Y.
Treasurer: William H. Laughridge, retired general boiler inspector, Hocking Valley R. R., 537 Linwood Avenue, Columbus, O.
Executive Board—Chairman: J. L. Callahan, general boiler inspector, Chicago Great Western, Oelwein, Ia.

American Boiler Manufacturers' Association

President—Owsley Brown, Springfield Boiler Company, Springfield, Ill.
Vice-President—S. H. Barnum, The Bigelow Company, New Haven, Conn.
Secretary-Treasurer—A. C. Baker, 709 Rockefeller Building, Cleveland.
Executive Committee (Three years)—Walter F. Keenan, Jr., Foster Wheeler Corporation, New York. E. E. Knobloch, Union Iron Works, Erie, Pa. C. W. Miller, E. Keeler Boiler Company, Williamsport, Pa. A. G. Weigel, Combustion Engineering Corporation, New York. (Two years)—F. H. Daniels, Riley Stoker Corporation, Worcester, Mass. M. E. Finck, Murray Iron Works, Burlington, Ia. A. G. Pratt, Babcock & Wilcox Company, New York. (One year)—A. W. Strong, Strong-Scott Manufacturing Company, Minneapolis. R. B. Mildon, Westinghouse Electric & Manufacturing Company, Philadelphia, Pa. R. B. Dickson, Kewanee Boiler Corporation, Kewanee, Ill. (Ex-Officio)—Owsley Brown, Springfield Boiler Company, Springfield, Ill. S. H. Barnum, The Bigelow Company, New Haven, Conn.

Office of Industrial Recovery Committee,
15 Park Row, New York

Manager—James D. Andrew.
Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President—Murrel J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

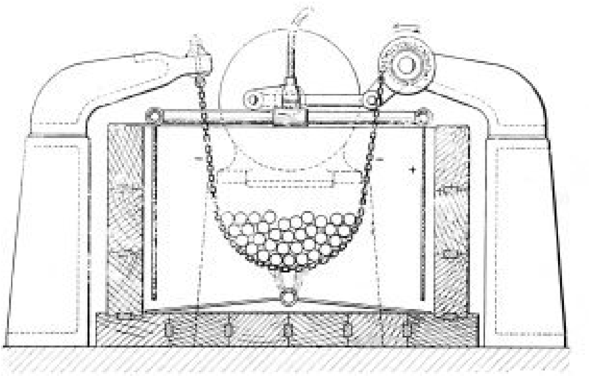
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent Attorney, 1372-1376 National Press Building, Washington, D.C. Readers wishing copies of patents or any further information regarding any patent described, should correspond directly with Mr. Galt.

1,885,602. PROCESS OF CLEANING SCALE FROM BARS. ELWOOD T. ICKES, OF PITTSBURGH, PENNSYLVANIA.

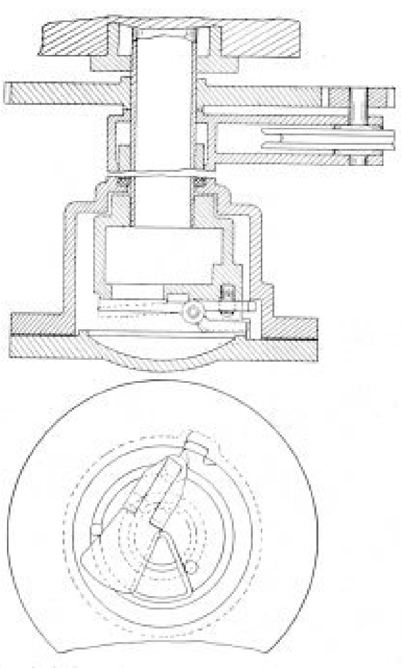
Claim.—A process of pickling a plurality of bars, rods, and the like articles formed of ferrous metal, comprising suspending the articles



in a bath of mineral acid heated to an elevated temperature and containing from about 0.5 to 3.0 percent of acid, and tumbling the articles upon themselves while passing a direct electric current from a ferrous metal anode through the bath to the articles as cathodes, the current density being from about 2.5 to 40 amperes per square foot of exposed cathode surface, and thereby removing surface scale from the articles and providing them with clean ferrous metal surfaces. Three claims.

1,870,182. BOILER CLEANER. NORMAN L. SNOW, OF NEW CANAAN, CONNECTICUT, AND FRANK BOWERS AND CURTIS L. HOWSE, OF DETROIT, MICHIGAN, ASSIGNORS TO DIAMOND POWER SPECIALTY CORPORATION, OF DETROIT, MICHIGAN, A CORPORATION OF MICHIGAN.

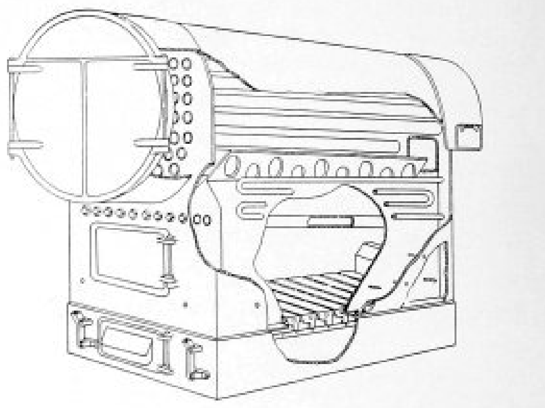
Claim.—The combination with a rotary blower element and means for rotating the same, of a valve movable into open and closed positions for



controlling the admission of cleaning fluid to said blower element, said valve being movable with said blower element and also movable relative thereto, means for moving the valve relative to the blower element to control the admission of the cleaning fluid as aforesaid and means for automatically moving the valve to relieve the friction opposing an opening movement of said valve relative to said blower element. Twenty-three claims.

1,870,059. BOILER. CLARENCE B. LITTLE AND WALTER J. HAAG, OF DAYTON, OHIO, ASSIGNOR TO THE BROWNELL COMPANY, OF DAYTON, OHIO, A CORPORATION OF OHIO.

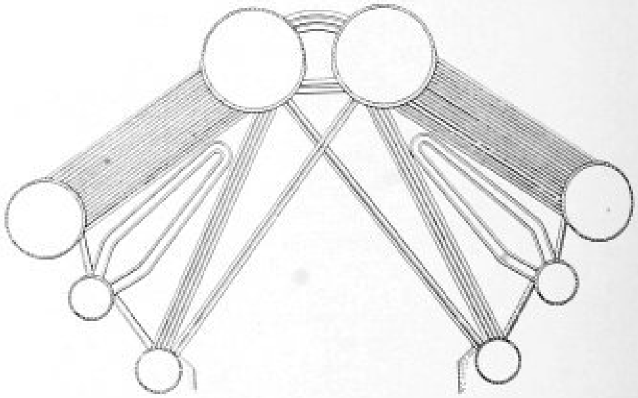
Claim.—In a boiler, the combination of a continuous sheet forming the inside and outside of side water legs and the sides and top of the boiler, an accurate arch brace sheet forming the crown sheet of the boiler welded



along its edges to the interior of the first mentioned sheet and welded to the top of the inside sheets of the water legs with the part of the sheet between the welds being straight and having apertures in said straight part for circulation between the legs and the boiler, whereby when the structure is assembled and welded it forms a continuous integral braced structure without rivets or bolts, and braces transversely arranged between the walls of the water legs formed by said continuous sheet. Six claims.

1,875,792. WATER TUBE BOILER OF THE YARROW TYPE. HAROLD EDGAR YARROW, OF SCOTSTOUN, SCOTLAND.

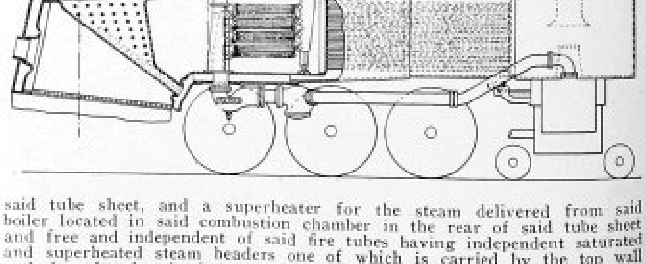
Claim.—A water tube boiler of the Yarrow type, comprising two parallel steam drums and a plurality of water drums on each side of the furnace and parallel with the said steam drums, inclined banks of steam generating tubes connecting the water drums at each side of the furnace with the steam drum on that side and a plurality of rows of steam generating tubes on both sides of and immediately adjacent to the combustion space



and directly connecting the innermost water drum on each side of the furnace with the steam drum on the opposite side of the furnace, the tubes of each row of said plurality of rows of steam generating tubes registering, respectively, with tubes of the adjacent row transversely of said steam and water drums and being spaced apart longitudinally of said steam and water drums approximately twice the distance between adjacent tubes of said banks of steam generating tubes to preclude "bird-nesting," while still effectively screening the parts of the steam drums which would otherwise be exposed to direct radiation from the furnace as well as balancing the pressure in the said steam drums.

1,876,766. LOCOMOTIVE AND SUPERHEATER THEREFOR. EUGENE L. SCHELLENS, OF RIDGEWOOD, NEW JERSEY, ASSIGNOR TO C-S ENGINEERING COMPANY, OF ENGLEWOOD, NEW JERSEY, A CORPORATION OF DELAWARE.

Claim.—A locomotive boiler having a combustion chamber, a rear tube sheet forming the front wall of said chamber, fire tubes terminated at



said tube sheet, and a superheater for the steam delivered from said boiler located in said combustion chamber in the rear of said tube sheet and free and independent of said fire tubes having independent saturated and superheated steam headers one of which is carried by the top wall and the other by the bottom wall of said combustion chamber. Fourteen claims.

Boiler Maker and Plate Fabricator

Annual Index

The annual index of Boiler Maker and Plate Fabricator for the year 1935 will be mailed without cost to each subscriber whose request for it is received at our New York office on or before January 15, 1936.

New Materials and Equipment

Advances in metallurgy, in equipment, in production methods—developments in the welding art—have combined to open a new range of possibilities in the heavy plate industries. Hardly a month goes by that some outstanding accomplishment in this field does not occur. In this issue, for example, are described several such notable achievements.

Stainless steel known as 18-8, by the addition of columbiun or titanium reaches its full stature as a non-corrosive material when welded properly. The development of suitable welding rod and the technique of welding 18-8 stainless steel have done much to overcome the former difficulties with this material in fabricating products of all types exposed to corrosive agents.

In the fabrication of heavy machinery as exemplified by the hydraulic press described elsewhere in the issue, welding has been employed to reduce weight and to promote economy of production. Designs of all manner of equipment are susceptible of great simplification when the welding processes and the cutting torch are advantageously applied to a problem.

Accompanying the advance in technique is a constant evolution in welding equipment. Simplicity, economy, and above all, quality, speed and uniformity of the work produced by a given apparatus constitute a yardstick by which such equipment is measured today. Welding machines must be qualified to perform satisfactorily as well as the operator. Never before has there been a time when so much that is new and advantageous from a production standpoint in the way of equipment has been available to industry.

All this leads up to the opportunity which exists for readers of Boiler Maker and Plate Fabricator to present outstanding developments in work performed and equipment used on unusual jobs. The pages of this publication are open at all times for descriptions of manufacturing methods and materials in the boiler and plate fabricating fields; of equipment employed on special jobs of outstanding or unusual character; and of the practical methods developed by the men in the shop for executing the ideas of the design and production departments.

Whether it is a company or an individual having such a story to tell does not matter. The only measure of the value of such descriptive material will be the information it can convey to our readers. All articles received will receive careful consideration and if found suitable will appear in an early issue thereafter.

Qualifying Tests for Welders

A brief notice to manufacturers of boiler and pressure vessels from the director of the Bureau of Navigation and Steamboat Inspection, recently called attention to the fact that very few concerns had carried out the specified tests qualifying their welders for production on materials and equipment for marine service. An extension until January 1, 1936, was granted in which such qualification tests could be undertaken.

While comparatively few manufacturers are engaged in the fabrication of pressure vessels for installation on merchant or naval vessels, nevertheless many of them from time to time have an opportunity to bid on marine work. Unless their operators are qualified for this type of work, a rapidly increasing market for a wide range of plate products will be lost to them.

The entire matter of testing welding operators is very much in a muddle at present. No common standard exists that will be acceptable to the various official bodies which have to deal with the safety of boilers, pressure vessels and other welded structures.

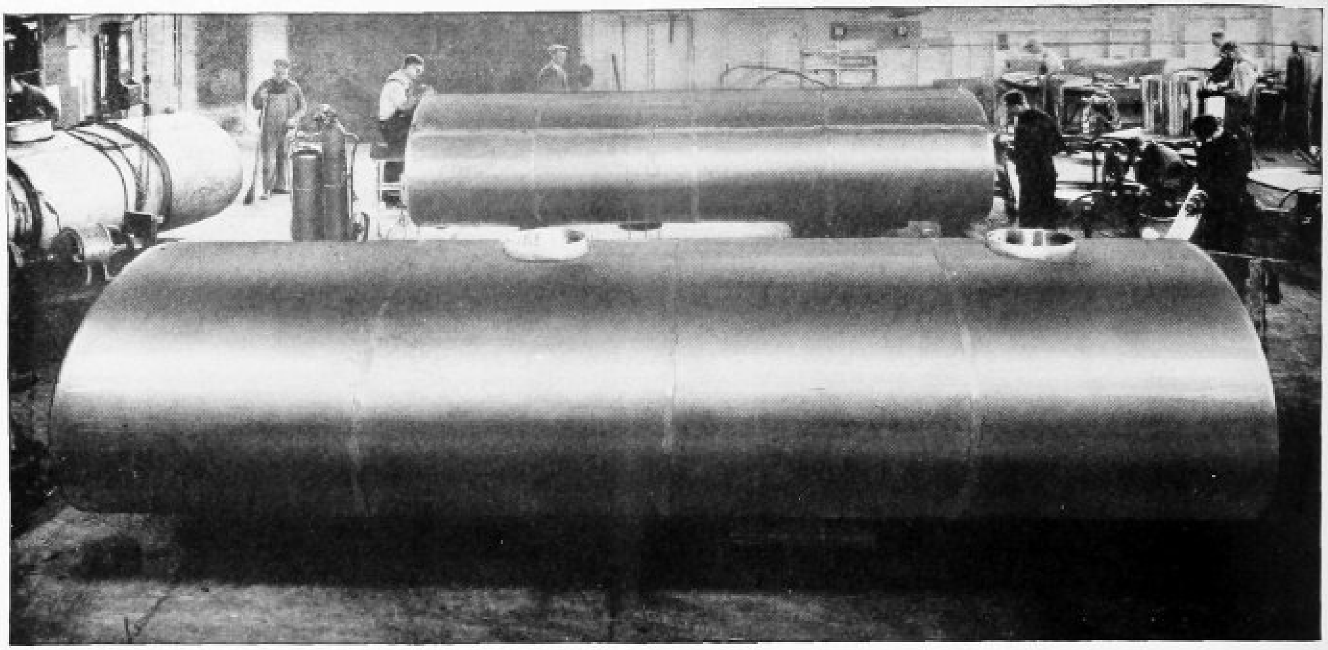
The need for a uniform test procedure has become so apparent that the American Welding Society is now undertaking the formulation of a test code. In general the endeavor of the committee dealing with this matter will be to correlate all codes pertaining to qualifying operators. Of necessity a wide range of plate products manufactured from many different materials and by varying technique will be covered by the code. The objective will be to provide tests which will be sufficiently critical to determine the ability of operators to meet the specification requirements of any welding process and procedure.

After the committee has formulated a tentative code, every opportunity to criticize the provisions will be accorded interested organizations and individuals. From such criticisms and discussions, it is hoped that a code entirely acceptable to official bodies will be developed. The rules in their tentative form will be published within a short time.

Business of the Industry

Boiler production and plate fabricated products figures released by the Department of Commerce indicate that the year will close with a far better record than that of 1934. In October the industry produced 787 boilers of 784,341 square feet heating surface. For the first 10 months of the year, 5856 boilers were constructed having a heating surface of 5,093,433 square feet. In the same period last year 4231 boilers of 3,822,066 square feet were built.

October production in the plate fabricating field amounted to 30,530 tons as compared with 16,581 tons in October, 1934. The total production for 10 months amounts to 203,615 tons.



Modern production methods adopted in tank fabrication

Improved methods of

Fabricating 18-8 Chromium Steels

By Owen C. Jones*

Introduction of the columbium-treated 18-8 stainless steel welding rod marks an important advance in the fabrication of stainless steel products.

The use of this rod in conjunction with 18-8 base metal "treated" or "stabilized" with columbium or titanium permits the fabrication of welded stainless steel products which, in the as-welded condition, have full resistance to corrosive and oxidizing influences, particularly at elevated temperatures.

While no attempt will be made to go into a detailed technical explanation of the subject, a brief discussion of 18-8 stainless steel and its welding characteristics will assist in pointing out the reasons for the advantages of welds made with the new columbium-treated 18-8 welding rod.

Outstanding Properties. The outstanding property of 18-8 stainless steel is its ability to resist many types of chemical corrosion, combined with a relatively high degree of ductility and malleability. Many industries, such as oil, chemical, food and dairy, pulp and paper, and many others have benefited greatly by the development of this alloy. The designer and builder of equipment for these fields thus has been given a steel from which equipment can be made that will have many times the life of other steels formerly used. In some cases it has found use where previously ferrous materials were not permissible.

Until recently a limiting factor in the use of 18-8 stainless steels was that certain service conditions had a tendency to lower their corrosion resistance by producing a susceptibility to intergrandular corrosion. Welding also was found to cause the same susceptibility in narrow zones in the base metal near the weld. In some cases, heat-treatment after welding would restore the desired properties but this was not always feasible.

Carbon Content Important. The carbon content of 18-8 stainless steel has an important effect on its corrosion resistance. Increase in the carbon content causes a rapid decrease in the ability of this steel to resist corrosion at elevated temperatures or after it has been heated during fabrication, as in welding. The so-called low carbon 18-8 stainless steel, which is the type most generally used for high corrosion resistance, is usually specified as maximum 0.10 or 0.07 percent carbon depending on the severity of the intended service.

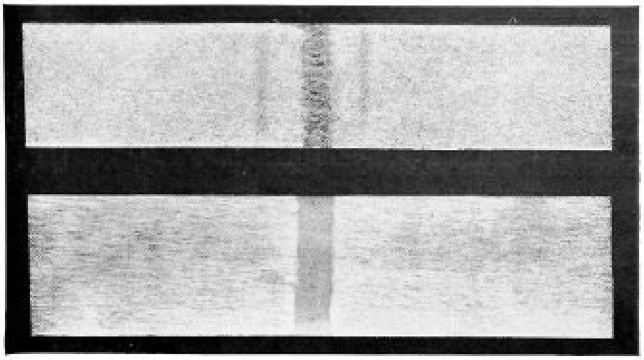
The metallurgical reasons for the development of susceptibility to intergranular corrosion can be explained as follows: When an 18-8 steel is cooled *rapidly* from high temperatures, as is normally done in its manufacture, the material retains a homogeneous structure, with carbon and other constituents in solution with the iron base metal. In this condition it is quite corrosion-resistant. However, when this steel is reheated to a temperature within the approximate range of 500 to 1400 degrees F., a new constituent, a carbide, is precipitated or thrown out of solution. This tends to form at the boundaries of the individual grains forming the metal structure. The formation of this precipitate lowers the corrosion resistance of the material at this point to a degree. This allows the destruction of the material by intergranular corrosion under conditions that it should normally resist.

In welding, then, the critical 500 to 1400 degrees F., range is passed and exceeded. As the heat passes this

* Technical department, Linde Air Products Company, New York.

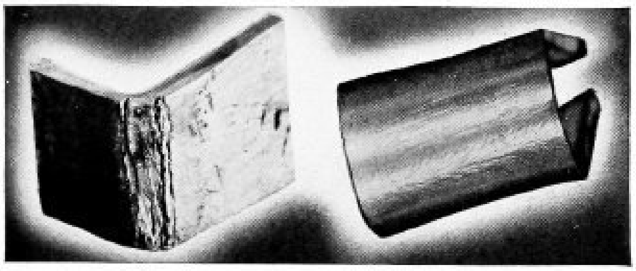
range slight precipitation may take place, but the higher heat of welding permits complete solution to take place again. Cooling of the weld metal usually is rapid enough to prevent precipitation as the metal passes through the critical range. Thus the weld itself retains to a large extent the corrosion-resisting properties of the original base metal. There is a zone parallel to the weld in the base metal, however, that is brought to the critical range because of the welding heat. The metal in this zone remains heated within the critical range for a sufficient length of time and cools at a slow enough rate so that precipitation takes place and this zone is subject to intergranular corrosion. Before the advent of the newer "treated" 18-8 steels or the new welding rod, full corrosion resistance after welding could be obtained only by reheating the product to the high temperature necessary to put all of the carbon into solution again and cooling it rapidly.

Beneficial Effects of Columbium and Titanium. A great deal of study was given this problem, with the result that certain elements were found which, when added to ordinary 18-8 stainless steel, would eliminate the susceptibility to intergranular corrosion. The elements of greatest value for this purpose are columbium and titanium. When either of these elements is added in such amounts as to create the proper balance between the added element and carbon, formation of the precipitate is minimized or eliminated. This preserves the corrosion resistance of the alloy steel, even when it is heated subsequently to within the critical range. This further eliminates the necessity of subsequent reheating or annealing to a temperature above that range, followed by rapid cooling after fabrication. This discovery led to the development of the so-called "treated" or "stabilized" 18-8 stainless steels which have a wide use in commercial applications when high corrosion resistance is necessary.



Effect of columbium on stainless steel

These two specimens illustrate the effect of adding columbium to stainless steel. Top—Stainless 18-8 steel, 0.06 percent carbon no columbium, oxy-acetylene welded followed by test in nitric hydrofluoric acid solution. Note bands of intergranular corrosion on each side of weld. Bottom—Stainless 18-8 steel, 0.06 percent carbon, containing 0.67 percent columbium, oxy-acetylene welded, similarly tested in nitric hydrofluoric acid. No signs of corrosion are apparent. The difference in appearance between the weld and base metal in each case is due to the inherent difference in structure between weld metal and rolled base metal.

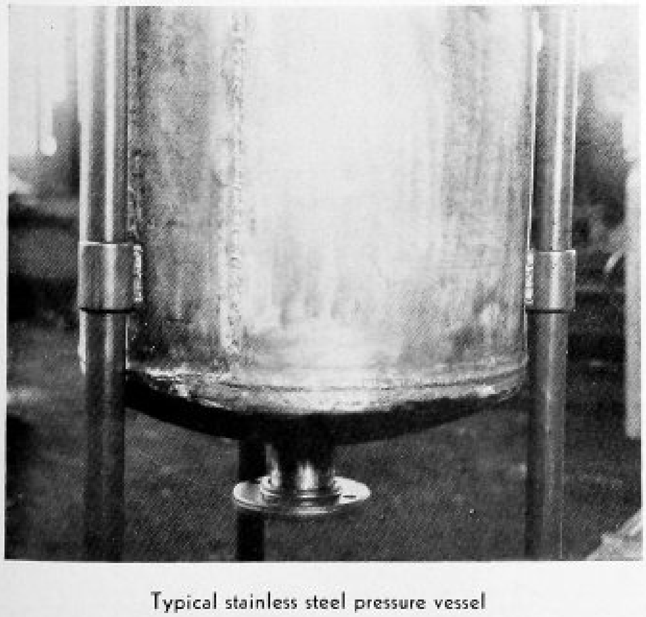


Bend tests of welded specimens

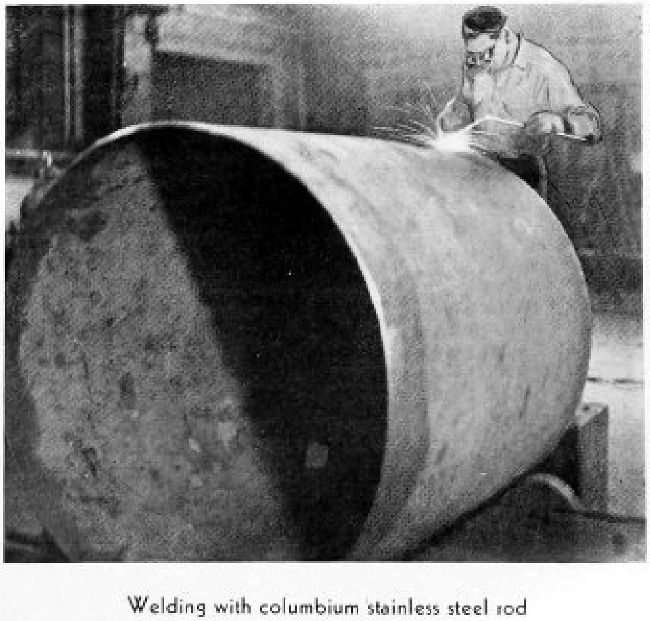
A bend test (right) in columbium-treated 18-8 stainless steel, oxy-acetylene welded, after boiling for 400 hours in acidified copper sulphate solution. Note the complete absence of cracking, showing absence of intergranular corrosion. Compare this with the left picture showing an untreated 18-8 steel specimen similar in every way except that it did not contain columbium.

Columbium in the Welding Rod

While the presence of either element in the base metal is effective in eliminating the heat effect, columbium is more advantageous for use in the welding rod. This element is not burned out of a rod of proper analysis to any extent during welding. The result is that an analysis of the weld and the metal adjacent to it shows that nearly all of the columbium of the rod has been carried through the welding process to give a treated weld fully as capable of resisting corrosion as before fabrication. Therefore, the use of the treated or stabilized 18-8 stainless steel base material and the new columbium-treated stainless steel welding rod allow fabrication of a welded article that will have all of the desirable corrosion-resistant properties of the base material without the need for subsequent heat-treatment.



Typical stainless steel pressure vessel

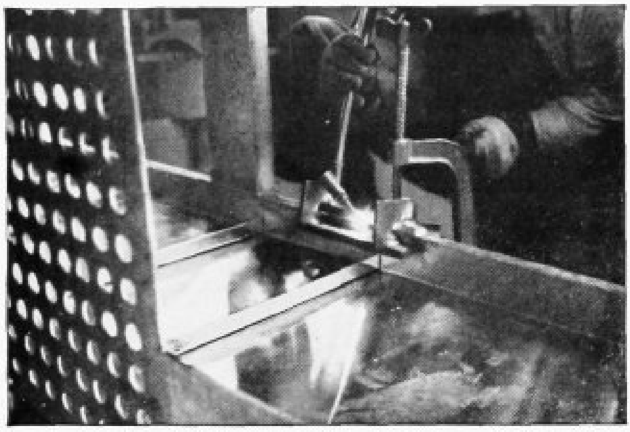


Welding with columbium stainless steel rod

Columbium is important in another way in that it counteracts the harmful effect of a slight carbon pick-up which is possible during the welding. The welding rod contains a sufficient amount of columbium to maintain the proper ratio to carbon and other alloying elements even after a small increase in carbon, to a maximum of about 0.10 percent, resulting from welding.

The procedure used in oxwelding 18-8 stainless steel is essentially the same as in welding ordinary steel. The

Typical clamps and chill plates



Jigs are useful in eliminating warping

only difference lies in the fact that certain precautions must be more carefully followed. Greater care must be exercised in welding 18-8 steel, particularly of the treated or stabilized types, in order to obtain the most desirable results.

Flame Adjustment Important. The properties of welds in stainless steels are greatly affected by the type of flame employed. The flame should be adjusted to give a neutral condition in which equal volumes of oxygen and acetylene are consumed. This regulation is understood and made without difficulty by those experienced in the use of the blowpipe.

Must Use Flux. The use of Cromaloy flux is strongly recommended in welding 18-8 steel. It makes the control of the molten metal easier, and also insures a sound, clean, good-appearing weld.

The application of flux to either the seam or the welding rod can be easily and quickly done by mixing the flux with water to the consistency of a thin paste and applying with a brush. The use of flux on the rod is particularly helpful in welding light-gage sheet. Advantages are also gained by painting the under side of the seam with flux, since this prevents oxidation and allows a more perfect union to be made along the bottom of the seam.

Welding Technique. Welding should be conducted in such a way as to prevent or minimize any tendency to puddle the weld. Puddling of the weld should be avoided since it increases the tendency toward oxidation and removal of the valuable constituents. The preferable welding technique consists in holding the rod ahead of the blowpipe so that the molten metal melts in place or is melted simultaneously with the base metal to form a union between the parts being welded.

The heat used in welding stainless steel should be the minimum that will give the results desired. Excessive heat on molten columbium-treated 18-8 steel increases the loss of columbium during the welding. The normal heat keeps the loss of this element to a small allowable percentage of that contained in the rod.

The choice between forehand and backhand welding depends chiefly on the skill of the operator in either method. In general, forehand welding is preferable on light-gage sheet, while backhand welding is better on the heavier gages.

When working on stainless steel, it is customary and advisable to weld from one side entirely. Care should be taken to fill the seam completely so that there will be no occasion to return to some point which should have been finished as the weld progressed.

It is important not to stop or to retrace a hot weld. If this must be done wait until the weld cools entirely.

If it should become necessary to go back over a weld, or if there is need for welding at the back side of the seam, in order to eliminate severe stresses the entire seam should be preheated before the flame is applied to the local area of the joint. Such preheating is frequently undesirable because of the likelihood of warping of the metal, and because slow cooling is harmful to the stainless steel. In other words, complete the weld in one pass, get thorough penetration in one pass, and do not make it necessary to work over or touch up a weld in any way.

Another operation against which the operator must be cautioned is welding away from an edge. In case it is necessary to weld away from an edge, begin the weld an inch or two in from the edge, then return to the starting point later to complete the weld to the edge.

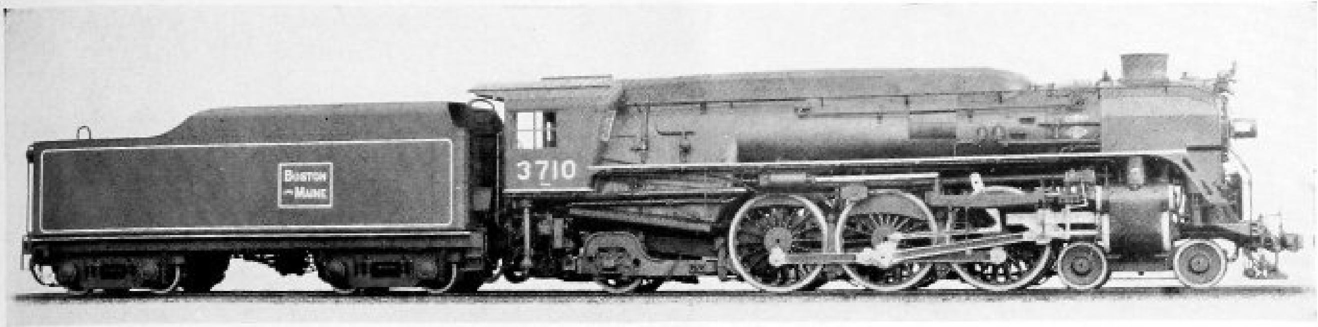
The operator should familiarize himself thoroughly with the recommended procedure before any fabrication is attempted. The columbium-treated rod flows easily and smoothly and very high quality welds may be expected. The welds will have good strength and will be completely corrosion-resistant in the as-welded condition. The completed structure therefore may be used without the need of subsequent heat-treatment.

Simplifying Fabrication Problems

It has been found helpful to place the parts being joined so that the line of weld inclines slightly downward in the direction of the welding. In this way, the flux, which fuses at lower temperatures than the steel, can flow forward and consequently provide protection for the metal as it fuses.

As compared to ordinary steel, the 18-8 stainless steels have a much higher coefficient of expansion with, at the same time, lower thermal conductivity. Because of these properties, welding, especially when applied to thin material, may cause distortion and warping unless suitable provision is made to prevent this action. Clamps, copper chill plates, and jigs are used separately or in combination to hold the plates in line until the weld has cooled. Greater ease and speed in welding are other advantages obtained by the use of these appliances. Less absorption of heat in the part welded, and more rapid chilling are also further advantages.

(*Continued on page 339*)



Class P-4-a Pacific type locomotive built by the Lima Locomotive Works for the Boston & Maine

Boiler features of Pacific and Mountain type

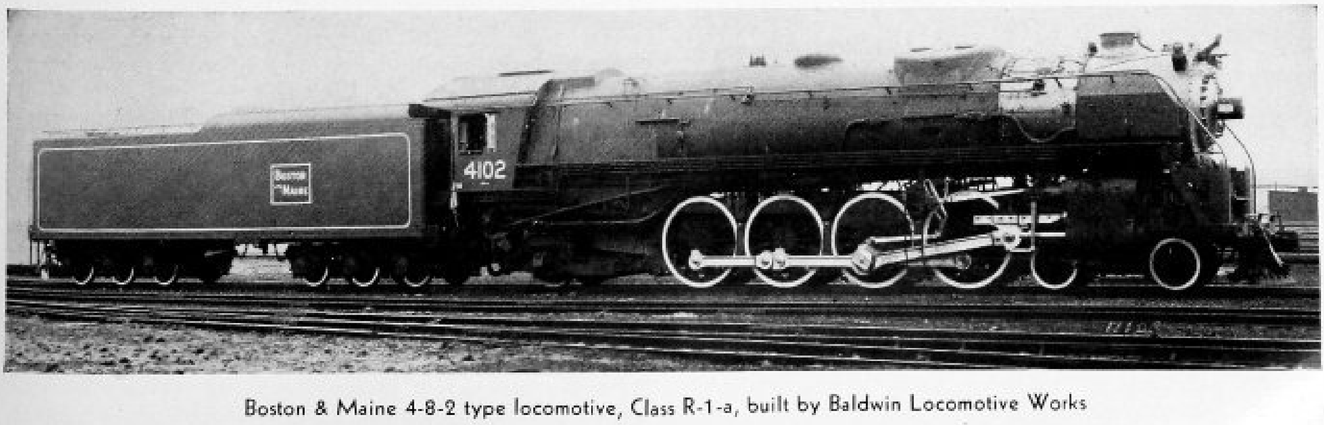
Boston & Maine Locomotives

During the past year the Boston & Maine has acquired five new Pacific type locomotives, built by the Lima Locomotive Works, Inc., which are known on the road as Class P-4-a, and are numbered 3710 to 3714, inclusive. These locomotives are more powerful than any previous Pacific type locomotives on this road. They are heavier, carry a higher steam pressure, and have larger drivers. Their weight in working order is 339,200 pounds, exclusive of the tender, of which weight 209,-500 pounds is on the drivers, 61,400 pounds on the front truck, and 68,300 pounds on the trailing truck. The steam pressure carried is 260 pounds per square inch, the cylinders are 23 inches by 28 inches, spaced 90 inches center to center, and the driving wheels 80 inches in diameter, with 73-inch centers. This gives a tractive force for the main engine of 40,900 pounds. The locomotives are also equipped with Franklin trailer boosters, which increase the total tractive force to 52,800 pounds.

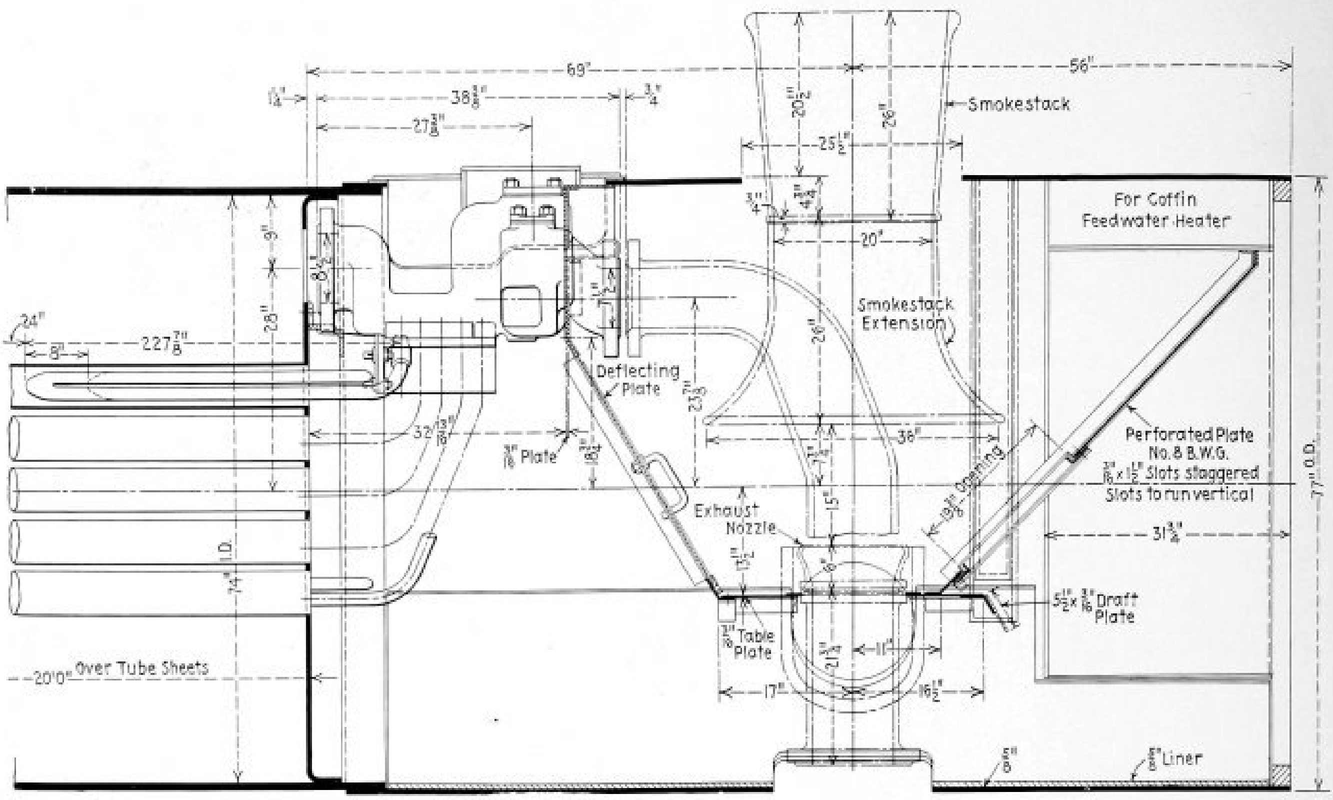
In addition to the large drivers and high tractive force required for handling heavy trains at high speeds, the locomotives have been partially shrouded to assist in reducing wind resistance and have smoke lifters or deflectors on each side of the smokebox, the purpose of which is to direct the flow of air when the locomotive is in operation in such a way as to lift the smoke and carry it above the line of the train. Owing to restricted clearances, the height of the stack has been kept down to 14 feet, 10½ inches and the width overall to 127 inches; the maximum weight per driving axle to 69,900 pounds. The light weight of the locomotive alone, without coal or water, is 310,000 pounds.

The boiler is of the radial-stayed extended wagon top type, measuring 75¾ inches outside diameter at the first course and 85 inches outside diameter at the dome course. The firebox is 114.5 inches long by 85 inches wide, which provides a grate area of 66.9 square feet. The grates are of the firebar type. The fuel used is bituminous coal, fired by a Standard HT stoker. Three Nicholson Thermic syphons, on which the brick arch is carried, are fitted in the firebox. Flexible staybolts are employed in the water space and for the crown. The firedoor is a Franklin Butterfly No. 8a. There are 203, 2¼-inch tubes and 40, 5½-inch flues. The net gas area through the tubes and flues is 1509 square inches. The superheater is an Elesco Type A having 966 square feet of heating surface. The evaporating heating surface of the firebox is 320 square feet, of which 100 square feet is in the syphons, and that of the tubes and flues is 3528 square feet, giving a total evaporating heating surface of 3848 square feet.

The locomotives are fitted with Coffin feed-water heaters and American multiple type throttle valves. The exhaust nozzle is of the annular ported type developed



Boston & Maine 4-8-2 type locomotive, Class R-1-a, built by Baldwin Locomotive Works



Smokebox arrangement of Boston & Maine Pacific type locomotives Class P4a

on the Boston & Maine. With a 6-inch diameter cover plate the free exhaust opening is 39.25 square inches. Exhaust ports at the cylinder saddle are 4½ inches by 10½ inches. Superior flue blowers are also used.

Referring to the illustration of the Pacific type locomotive it will be noted that all projections and equipment from the sandbox to the cab have been shrouded under an extension of the locomotive jacket. In addition to the sandbox, the parts shrouded include the dome, safety valves, headlight generator and cab turret. The stack is an oval shape, with a separate passage on the front side which carries the exhaust from the booster and the boiler feed pump. No other shrouding was included in the design.

The tender is of the rectangular type mounted on a cast-steel, open-bottom type underframe made by the General Steel Castings Corporation. These tenders weigh 240,300 pounds loaded, or 104,000 pounds light, and have a capacity for 12,000 gallons of water and 18 tons of coal. The distance from the rail to the deck is 83⅜ inches. The total length of the tender is 38 feet 4⅛ inches and engine and tender over coupler faces is 88 feet 8 7/16 inches.

Mountain Type Locomotives

The five mountain type locomotives, which were built by the Baldwin Locomotive Works, are the first locomotives of the 4-8-2 type placed in service on the Boston & Maine. Previous freight locomotives which had been purchased since 1920 were all either 2-10-2 type, with 61-inch drivers, or 2-8-4 type, with 63-inch drivers. The new locomotives are numbered 4100 to 4105 and are known on the road as Class R-1-a. They have 73-inch drivers, with 66-inch wheel centers, and the boilers are of generous capacity. This fits them well either for heavy fast freight or when required for heavy passenger service.

These locomotives weigh 416,100 pounds in working order, of which 269,400 pounds is on the drivers, 78,900 pounds on the front truck and 67,800 pounds on the trailing truck. The light weight of the engine alone, without coal or water, is 376,100 pounds. The steam pressure carried is 240 pounds per square inch. The cylinders are 28 inches by 31 inches, spaced on 92-inch centers. This gives a rated tractive force of 67,000 pounds. Smoke lifters or deflectors are provided on each side of the smokebox. Clearances being restricted, the height of the stack was made 15 feet 4⅞ inches, and the width overall 127 inches. The maximum axle load is 68,900 pounds.

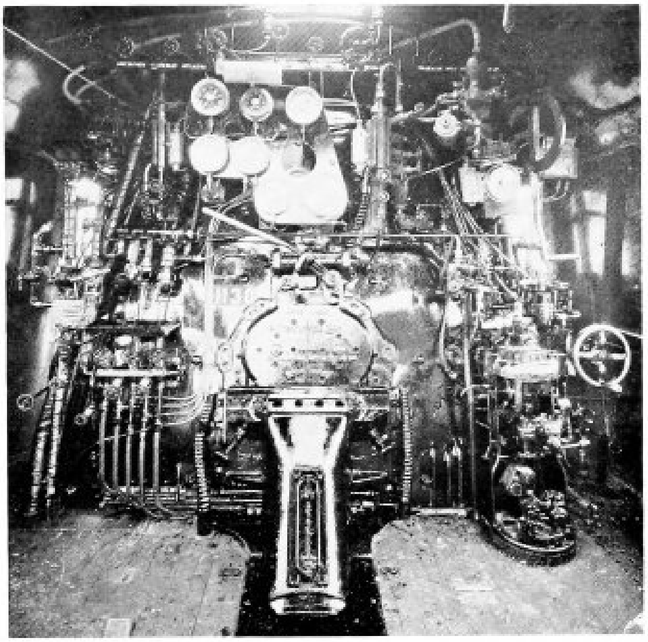
The outside diameter of the first ring of the radial-stayed boiler is 84 inches, and the large diameter next to the throat sheet is 96 inches. The center of the boiler is 126 inches above the top of the rail. The firebox is 126⅛ inches long by 90 inches wide, which gives a grate area of 79 square feet, and is fitted with three Nicholson Thermic syphons. An additional syphon is also placed in the combustion chamber which is 66 inches long. Fuel is bituminous coal, fired by a Standard HT stoker, and grates are of the Firebar type. There are 53, 2¼-inch tubes and 201, 3½-inch flues, the length over tube sheets being 19 feet. The evaporating heating surface of the firebox, including 122 square feet in the syphons, is 474 square feet, and for the tubes and flues 4070 square feet, which gives a total evaporating heating surface of 4544 square feet. The Type E superheater contains 1924 square feet of heating surface. The net gas area of the tube and flues is 1845 square inches.

Coffin feedwater heaters are fitted to these locomotives. The cylinder saddle is carried well up on the smoke arch and has pockets which permit the steam pipes to be located entirely inside the smokebox chamber. The smoke stack is 50½ inches long, 20½ inches diameter at the choke, and has a 36-inch diameter flare at the lower end. The distance from the top of the exhaust nozzle to the smoke stack is 18 inches. The exhaust

Table of Dimensions, Weights and Proportions of B. & M. Locomotives

Railroad	B. & M.	B. & M.
Builder	Lima	Baldwin
Type of locomotive	4-6-2	4-8-2
Road class	P-4-a	R-1-a
Road numbers	3710-3714	4100-4104
Cylinders, diameter and stroke, in.	23 by 28	28 by 31
Valve gear, type	Walschaert	Walschaert
Valves, piston type, size	12 in.	14 in.
Maximum travel	8 in.	7½ in.
Steam lap	1 17/32 in.	1¼ in.
Exhaust clearance	3/16 in.	⅛ in.
Lead in full gear	¼ in.	5/32 in.
Weights in working order:		
Total engine	339,200 lb.	416,100 lb.
On drivers	209,500 lb.	269,400 lb.
On front truck	61,400 lb.	78,900 lb.
On trailing truck	68,300 lb.	67,800 lb.
Tender	240,000 lb.	377,350 lb.
Wheel bases:		
Driving	14 ft. 0 in.	19 ft. 3 in.
Rigid	14 ft. 0 in.	12 ft. 10 in.
Engine, total	36 ft. 11 in.	44 ft. 2 in.
Engine and tender, total	77 ft. 7 in.	92 ft. 8 in.
Wheels, diameter outside tires:		
Driving	80 in.	73 in.
Front truck	36 in.	36 in.
Trailing truck	49 in.	38 in.
Boiler:		
Steam pressure	260 lb.	240 lb.
Diameter, first ring, outside	75¾ in.	84 in.
Diameter, back end, outside	85 in.	96 in.
Firebox, length and width in.	114⅛ by 84	126⅛ by 90¼
Height mud ring to crown sheet, back	68½ in.	71⅝ in.
Height mud ring to crown sheet, front	89 in.	87¾ in.
Arch tubes	None	None
Syphons	3	4
Combustion chamber, length	None	66 in.
Tubes, number and diameter	203—2¼ in.	53—2¼ in.
Flues, number and diameter	40—5½ in.	201—3½ in.
Net opening through tubes and flues	1,509 sq. in.	1,845 sq. in.
Length over tube sheets	20 ft. 0 in.	19 ft. 0 in.
Fuel	Soft coal	Soft coal
Stoker	Std. HT	Std. HT
Grate, type	Firebar	Firebar
Grate area, sq. ft.	66.9	79
Superheater, type	A	E
Feedwater heater	Coffin	Coffin
Heating surfaces, sq. ft.:		
Firebox and comb. chamber	220	352
Syphons	100	122
Firebox, total	320	474
Tubes and flues	3,528	4,070
Total evaporative	3,848	4,544
Superheating	966	1,924
Comb. evap. and superheat	4,814	6,468
Tender:		
Style	Rectangular	Rectangular
Water capacity	12,000 gal.	20,000 gal.
Fuel capacity	18 tons	21 tons
Trucks	Four-wheel	Six-wheel
Journals, in.	6½ by 12	6½ by 12
General data, estimated:		
Rated tractive force, 85 percent, engine	40,900 lb.	67,000 lb.
Rated tractive force, booster	11,900 lb.	.....
Potential horsepower (Cook)	2,913	3,862
Speed at 1,000 ft. piston speed	51.0 m.p.h.	42.1 m.p.h.
Piston speed at 10 m.p.h.	192.5 ft.	237.5 ft.
Boiler evapor. capacity, lb. per hr. (with heater) (Cook)	54,063	69,914
Weight proportions:		
Weight on drivers ÷ total weight engine, percent	61.8	64.8
Weight on drivers ÷ tractive force	5.13	4.03
Total weight engine ÷ potential hp.	164	177
Total weight engine ÷ comb. heat. surface	70.5	64.4
Boiler proportions:		
Firebox heat. surface, percent comb. heat. surface	6.65	7.33
Tube-flue heat. surface, percent comb. heat. surface	73.3	62.92
Superheat. surface, percent comb. heat. surface	20.05	29.75
Firebox heat. surface ÷ grate area	4.78	6.0
Tube-flue heat. surface ÷ grate area	52.7	51.5
Superheat. surface ÷ grate area	14.45	24.35
Comb. heat. surface ÷ grate area	71.9	81.9
Tractive force ÷ comb. heat. surface	8.5	10.35
Tractive force × dia. drivers ÷ comb. heat. surface	681	756
Comb. heat. surface ÷ potential hp.	1.65	1.68
Potential hp. ÷ grate area	43.55	48.90

ports at the cylinder saddle measure 6⅛ inches by 12¼ inches each. The exhaust stand or nozzle pipe tapers to 10¼-inch inside diameter and is 22¼ inches high. The exhaust nozzle is of the annular ported type developed on this road. The nozzle used on these locomotives is of 12-inch diameter over the exhaust ports and 6 inches high. The free area of the six ports is 48.07 square inches, which is reduced to 47.69 square inches by a central cover plate, 3½ inches in diameter.



Cab interior and back boiler head of the Boston & Maine 4-2-8 type locomotive

The tender is of the rectangular type, having a capacity for 20,000 gallons of water and 21 tons of coal. Its weight is 377,350 pounds loaded, or 160,300 pounds light. It is mounted on a General Steel Castings water-bottom underframe. The total length of the tender is 46 feet 4 inches and the combined length of engine and tender over coupler faces is 105 feet 8⅜ inches.

The principal proportions are shown in the table.

Welding 18-8 Treated Steel

(Continued from page 336)

In most instances, sheets 1/16 inch or less in thickness are flanged at the edge to a height of about 1/16 inch. The flanged edges are painted with the flux at both the top and bottom and are held in place as the flame melts down the flanges to form a smooth, moderately reinforced weld.

Slightly heavier sheets up to ⅛ inch in thickness may have the edges butted together and oxwelded with some addition of metal from a welding rod. A backing strip, generally of copper, is used beneath the joint to prevent the liquid metal from flowing out of the weld.

For plates heavier than ⅛ inch the edges should be scarfed to provide a vee so that fusion entirely to the bottom of the weld can be obtained easily. Welding rod is, of course, used in making the weld.

Obviously a real victory has been gained in the war against corrosion. With satisfactory welding technique and this new welding rod which has proved so suitable for obtaining full corrosion resistance in treated or stabilized 18-8 stainless steels, new economies and more satisfactory products offer themselves to the fabricators and users of stainless steel equipment for services requiring resistance to corrosion.

Inspecting and maintaining oil

REFINERY PRESSURE VESSELS*

***By F. L. Newcomb*†**

To afford a better understanding of the problems involved in the inspection and care of oil refinery pressure vessels, it appears advisable to give a brief resumé of the developments in oil refining during the past twenty-five years. Prior to 1913, oil refining consisted principally of fractional distillation of crude petroleum. An effort was made to avoid pressure in this distillation due to its deteriorating effect on the lubricating oil fractions. After separating the crude into its various parts, the gasoline and kerosene distillates were finished by agitating a batch of oil with sulphuric acid followed by a treatment with caustic soda. Wax was removed from lubricating oil by chilling and pressing the oil through filters.

About 1913 the rapid increase in the use of the automobile created such a demand for gasoline that it was impossible to supply this demand without making excessive amounts of other products for which there was no demand. About this time, Dr. W. M. Burton of the Standard Oil Company of Indiana developed a pressure still in which the heavier fractions of crude could be cracked, resulting in the production of additional gasoline, with fuel oil as a residue. This apparatus was similar to a watertube type boiler, having a horizontal drum, usually 10 feet in diameter by 30 feet long, connected to a bank of 45 4-inch tubes by 2 18-inch circulator pipes. However, this differed from a watertube boiler in that only the tubes were in the furnace and none of the products of combustion came in contact with the drum. This operated at approximately 100 pounds pressure and up to 780 degrees F. This constituted the first really successful and widely adopted pressure distillation operation.

As the use of the automobile increased rapidly after this time, it led to active research by the various oil companies in an effort to produce more efficient cracking apparatus. Somewhat later, it was realized that, to increase the efficiency of the automobile engine, it was necessary to produce a gasoline which could be used with higher engine compression ratios without pre-ignition or, in other words, a gasoline with a better "knock rating," which led to still further research and development. The result was modern refinery cracking apparatus operating at 750 to 1000 pounds pressure and temperatures ranging from 900 degrees to 1100 degrees F.

Cracking operations led to much greater production of gas than formerly and it was found that this gas contained large quantities of light naphthas which could be reclaimed by compression or absorption by bubbling through heavier oils while under pressure. This resulted in the use of gas compression and absorption plants which contain a considerable volume of gas under pressures ranging from 30 pounds upward to several hundred pounds. Also the increased size of fired units necessitated higher pressure on the fuel gas lines and traps which are required for removal of any light naphtha on the fuel gas.

The very greatly increased production of gasoline caused the old batch treatment of gasoline with sulphuric acid and caustic soda to become obsolete and resulted in the development of a continuous method of treatment. This consists of a series of mixing chambers and settling drums through which the gasoline is pumped continuously while acid and soda is added and settled out and water washing operations are performed. This operates under sufficient pressure to overcome the friction of pipe lines and the resistance of the mixing chambers.

Improvement of oil by intimate contact with hydrogen, while under high pressure and temperature, entered the picture several years ago, due to development in Germany of the hydrogenation of coal tar derivatives. This necessitated pressures as high as 3700 pounds and temperatures ranging from 750 degrees to over 1000 degrees F., depending on the stock being processed and the product desired. This process is not yet in general use.

Developments in automobile engine design necessitated higher grades of lubricating oil to stand up under higher bearing pressures, adequately to seal the pistons of high speed engines and to flow freely at lower temperatures and still retain high viscosity at engine operating temperatures. The oil industry is now entering a new era of selective solvents refining of lubricating oils for removing asphalt, wax and other undesirable constituents from the lubricating oil stock. This involves the use and reclaiming of such substances as cresol, sulphur dioxide, croton aldehyde, aniline, furfurol, acetone, phenol, propane, dichlorethylene, trichlorethylene, and carbon tetrachloride. Most of this equipment operates under moderate pressures and temperatures ranging from 70 degrees F. below zero to several hundred degrees above zero. The experience with some of these solvents has been so limited, under the conditions of use, that little is known concerning the corrosion which may occur.

A modern complete oil refinery contains vacuum stills, atmospheric shell stills, pipe stills (some operating under low pressure and some under vacuum), cracking units, gas compression and absorption plants, gas holders, treating and sweetening units, filtering equipment, dewaxing equipment, solvent extraction equipment, paraffin wax units and presses, boiler houses, electrical generating equipment, air compressors and equipment, acid restoring plants, pumps, steam engines, electrical equipment, internal combustion engines, many measuring, recording and control instruments, a maze of pipe lines and many other things, including a large number of various sized tanks for the storage of crude and the various petroleum products.

Owing to the corrosive properties of the substances handled, many vessels have protective linings designed to prevent corrosion and others are made from corrosion-resistant alloys such as 4-6 percent chromium steel with small amounts of molybdenum or tungsten or the more expensive 18 percent chromium 8 percent nickel steels.

* Abstract of paper presented at the tenth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors.

† Supervising engineer, Safety Inspection Division, General Engineering Department, Standard Oil Development Company, Elizabeth, N. J.

Inspection of Equipment by Oil Companies

From the inception of the oil industry, refiners have been faced with the necessity of some kind of inspection of equipment. The investment in equipment has been so heavy that it has been necessary to obtain reliable and continuous operation to assure a fair return on the investment and still meet competitive prices. The failure of a comparatively minor piece of equipment might result in a fire which would damage a major part of the plant and render operations impossible over a considerable period of time. Aside from loss of return on the investment and the cost of repairs and replacements, this would also probably result in loss of customers and business to competitors. With today's complex operations and large sized units, reliable and continuous operation is even more a necessity.

The foregoing is aside from any humanitarian consideration. The oil industry has not been remiss from this angle. For many years all of the larger and a very large percentage of the smaller oil companies have been actively engaged in safety work and associated with the Petroleum Section of the National Safety Council. A few years ago, the American Petroleum Institute felt that this should be supplemented, and organized a safety division with a full time secretary. In addition, a committee was appointed to draw up a code for petroleum pressure vessels. The work of this committee culminated in the recent publication of the joint "API-ASME Code for the Design, Construction, Inspection and Repair of Unfired Pressure Vessels for Petroleum Liquids and Gases." These rules have been carefully formulated to care for all of the special conditions incident to petroleum pressure vessel service. They represent the experience and practice of the oil industry and cover both welded and riveted vessels. These rules go further than any former pressure vessel codes since they provide for the periodic inspection of these vessels, give rules covering repair, and are explicit as to the methods to be used in determining the allowable working pressure throughout the life of the vessel. This code also contains rules for determining the allowable working pressure of petroleum pressure vessels constructed prior to the formulation of these rules.

Before pressure equipment was extensively used in oil refining the inspection was made by mechanics in the trade most familiar with the type of equipment involved. Most refineries have mechanical shops and regularly employ a number of mechanics from the various trades. Petroleum vessels were inspected by men selected from the boiler makers and these inspectors reported to the head of the boiler department. Usually when such an inspector reported the need for repairs or replacements, the equipment was further examined by the chief boiler maker or one of the foremen and if they concurred with the inspector, the repair or replacement was made. Such inspection usually consisted of a visual examination, supplemented by hammering to detect thin areas or metal which had been overheated and lost its elasticity and other important properties. This was generally referred to as metal which was "dead."

At about the same time that cracking equipment was first used, oil was received from Mexico which contained highly corrosive and toxic sulphur compounds, including hydrogen sulphide. The increased demand for petroleum products, following the increasing production of automobiles, led to the development of many new oil fields both in the United States and abroad. Some of the most prolific of these fields produced oil similar in corrosive properties to that being found in Mexico. Today a considerable part of the crude oil being refined is of this character. The severe corrosion caused by this oil, coupled with the increased use of pressure equipment necessitated a change in the inspection methods in vogue.

About 1920, inspection of cracking equipment began to be shifted from the boiler makers to the technical organizations of the oil companies. This was the start of the elaborate and complete inspection organizations prevalent today among the oil companies. These organizations inspect almost all equipment, except that being adequately inspected by some state or local authority, whether it operates under pressure, no pressure or vacuum, unless long experience has shown that corrosion, or other deterioration, does not occur.

Present-day inspection forces of oil companies are organized along three general lines, depending on whether the company's plants are widely scattered or closely grouped or whether the company only operates one plant. Typical examples of organizations actually existing for each of the three above classifications are described below.

In a large company with widely scattered refineries, there is a central group which makes general periodic inspections of the equipment at stated intervals. This group has a semi-executive head who co-ordinates the entire work and has under him, at his headquarters, several well experienced assistants and a record clerk. Working under this office force there is a corps of traveling inspectors who go from point to point making general and complete inspections of all the equipment at fixed periodic intervals. This entire group, aside from the record clerk, is made up of graduate engineers who are able to make any necessary calculations and who have a fair knowledge of the processes involved in refining petroleum. Supplementing this central organization, there are local organizations at each of the individual refineries who care for such parts of the equipment as require inspection at more frequent intervals than the general periodic inspection. Each of the local organizations is in charge of a competent engineer (frequently one drawn from the central inspection group) thoroughly familiar with the design, construction and operation of refinery equipment. To carry out the inspection work, he generally uses competent mechanics trained for inspection. Some of the local organizations are directly under the supervision of the central group and others are independent organizations with whom the central group keeps close contact.

For a somewhat smaller company, with a number of closely grouped refineries, the inspection organization is a somewhat simplified modification of the above. Such an organization is also in charge of a semi-executive head with his headquarters centrally located and in close contact with the company management. Instead of having a corps of traveling inspectors, both periodic and run-to-run inspections are made by the refinery groups, this work being co-ordinated by the chief inspector of the company. In this case there are both graduate engineer inspectors to make the general periodic inspections and mechanical inspectors to make the run-to-run inspcetions in the local groups.

For a small company operating only one refinery, the inspection organization is reduced to its simplest form. A competent engineer, thoroughly familiar with the design, construction and operation of the equipment is in charge of the organization. He has a sufficient number of both engineering and mechanical inspectors to make the general periodic inspections and the necessary run-to-run inspections.

Most of the companies have inspection groups adapted to their own particular needs and that best fit into their general organization. Some companies operate pressure equipment under licenses granted by companies having elaborate inspection organization and receive the benefit of periodic inspection by this outside group to supplement their own inspection. Regardless of the form of organization of the inspection forces, most of the oil industry has careful and thorough inspection of its equipment, generally in charge of and frequently performed by graduate engineers.

The chief inspector is a person with considerable authority. He has the right to order repair or replacement of unsafe equipment and such order usually is obligatory. He issues instructions covering methods of making inspections and usually establishes the safe limits for the various equipment, taking all operating conditions into consideration. He keeps all interested parties informed concerning corrosion, failures, new methods of inspection and in general his office acts as a clearing house for accumulating and disseminating all essential information for the safe design and maintenance of equipment. He frequently confers with the local inspection groups, talks over with them problems of mutual interest and gives them the benefit of the broader experience he has acquired through contact with a number of plants.

Inspection organizations are not concerned with production of products other than that it is their business to enforce maintenance of a character that will assure reliable and continuous operation of equipment. Such operation cannot be assured unless the equipment is constantly maintained in a safe condition. The inspection forces generally do not come directly under the jurisdiction of those primarily in charge of either production of products or maintenance of equipment. Where there is an independent technical organization, the inspection forces usually are a part of such organization. In general, they are free to express their opinion concerning the condition of the equipment and the character of the maintenance without being influenced by someone whose primary interest is either in getting the maximum out of the equipment or of maintaining it at its lowest cost. Freedom to state conditions exactly as found and to criticize the condition of equipment without fear has been the primary reason for the success attained by oil refinery inspection organization.

(To be continued)

Two-Stage Reduction Regulator

The Air Reduction Sales Company, New York, announces a new heavy-duty two-stage pressure-reduction regulator known as Airco-DB style 8490, and primarily designed to deliver large volumes of oxygen at relatively high pressures such as may be encountered on heavy cutting jobs. It finds its use principally where the oxygen demand is greater than can be handled by the conventional regulator, or where close pressure regulation and a low end-point are desired. A further and important use of the regulator arises in cases where precise pressure regulation with medium flows is involved. Whenever the oxygen demand per regulator is in excess of 1000 to 1200 cubic feet per hour, it should be used even if low end-point and close regulation are not essential.

The maximum operating pressure is 200 pounds per square inch while the maximum delivery capacity is about 3000 cubic feet per hour providing the delivery pressure is 100 pound or greater. The pressure regulation is practically independent of the rate of flow from full cylinder pressure down to the regulation end-point. The pressure variation will generally be less than plus or minus ½ pound per square inch.

Departing from conventional design, this regulator uses the Airco laboratory-developed feed-back principle. The low-pressure cavity is connected to the space in back of the first-stage diaphragm by the passage through the control tube on the back of the regulator. The first-stage spring maintains a certain difference in pressure between the first and second stages, much in the same manner as in the usual two-stage welding regulator, although the pressure difference varies in the latter for different operating pressures. However, whenever the adjusting screw is turned in, and pressure developed in the low pressure cavity, the same pressure will be developed in back of the first-stage diaphragm; this pressure augments the effect of the control spring thrust so that the first-stage pressure increases by an amount equal to the operating pressure.

Heavy-duty regulator

The effect of the control tube is the same as though the first-stage side of the regulator were equipped with an adjusting screw of its own and this screw were turned in the same amount as the operating-pressure adjusting screw (for equivalent characteristics, a long and heavy control spring would be required). With this arrangement, the difference between the first- and second-stage pressures is always maintained substantially constant, with the difference being equal to the first-stage pressure when the adjusting screw is entirely released.

This feature is largely responsible for the excellent regulation obtained, because there is a definite relation between the first- and second-stage pressures which will give the best regulator characteristics. In welding regulators, the available pressure range is small compared to the pressure range of a cutting regulator, thus a varying pressure differential between the two stages is not as important as in the cutting regulator. By using the feed-back principle, the two stages keep pace with each other and the size and weight of the regulator are considerably reduced.

Collapsing Tube Causes Death

The collapsing of a boiler tube in an ice manufacturing plant in Alabama resulted in the death of one man and serious injury to another from escaping steam at about 80 pounds pressure. The boiler was being used to supply the peak ice demand due to the strawberry season when many cars of berries were being iced for shipment to northern markets. One of the men was in front of the boiler at the time of the accident and the other was on top of it. The man who was killed was the engineer and the other the manager.—*The Locomotive.*

Large rectangular tank fabricated by arc welding for use in treating rice

Chicago Bridge Works Fabricates 50-foot

ARC-WELDED TREATING TANK

A large rectangular tank which is to serve as a chamber for treating rice against infestation, and which is entirely arc welded, was recently completed at the Birmingham, Ala., plant of the Chicago Bridge and Iron Works for the Louisiana State Rice Milling Company at Abbeyville, La.

The accompanying illustration shows the treating chamber which is 50 feet long by 6 feet 6 inches wide by 6 feet high. The installation also includes an accumulator tank which is 2 feet 6 inches diameter by 18 feet. The thickness of plate in the treating chamber is 3/8 inch and in the accumulator tank, 17/64 inch.

The tank has a designed operating pressure of 100 pounds per square inch. The treating chamber is designed for 29½ inches minimum vacuum.

A total of 1750 linear feet of welding was required in construction. Of this amount, 350 feet is 3/8-inch bead, 1100 feet 3/16-inch bead and 300 feet 5/16-inch and ¼-inch beads. All welding was done with Fleetweld (shielded arc) electrodes supplied by The Lincoln Electric Company, Cleveland.

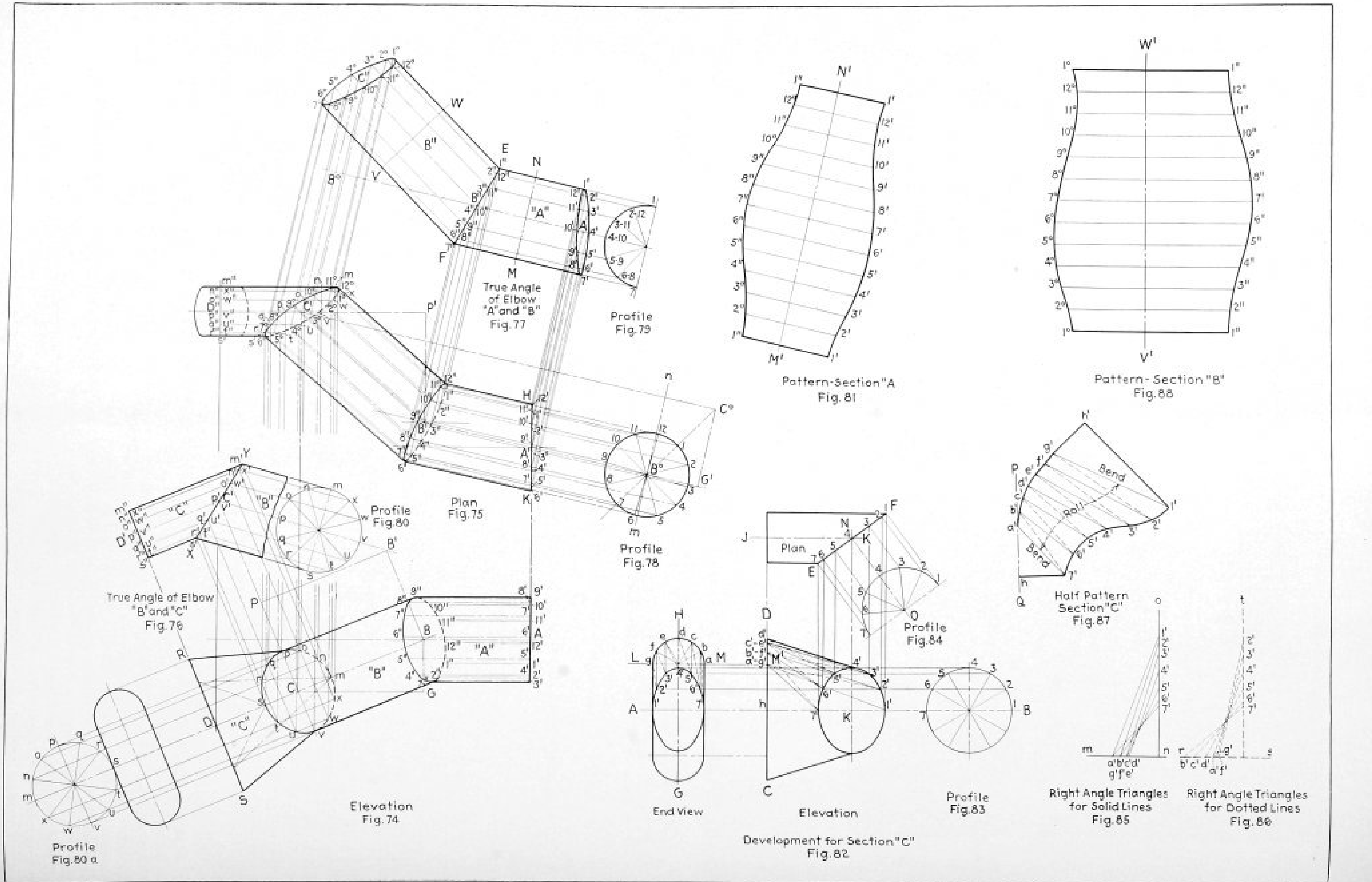
The special treating service for which this tank is to be used utilizes the Guardite process, developed by the Guardite Corporation, Chicago. The Guardite process is a vacuum fumigation method of treating foodstuffs, tobaccos, furs, etc., against infestation. The products are placed in a treating chamber either in the raw-material stage or after being completely packaged. The treating chamber is closed, a 29-inch vacuum is drawn on the chamber and gas is admitted.

The amount or dosage of gas depends upon the type of material which is to be treated and the length of the treating period. Ordinarily, an economical treating period is 2½ to 3½ hours as this permits a plant to handle two charges during the day and one at night. With an average treating period of three hours, the normal dosage is from 30 pounds to 40 pounds of gas per thousand cubic feet of treating chamber space.

The gas, which is a mixture of ethylene oxide and carbon dioxide, is shipped in cylinders under 800 pounds pressure. The gas is expanded to 75 pounds per square inch pressure in an accumulator tank and preheated to 120 degrees F. to assure its entering the chamber in the form of a true gas.

The principal advantages of using a vacuum treating chamber instead of an atmospheric treating chamber are that the gas will penetrate the charge quickly and thoroughly and the lack of oxygen increases the rate of respiratory metabolism of the adult insects, rendering them more susceptible to the toxic effect of the gas.

The treatment kills all forms of infestation including the egg. This gives thorough protection as it prevents insects from hatching after food products leave the manufacturer's plant due to being stored in warm warehouses or coming in contact with the proper conditions for hatching insects on the retailers' shelves. This protection has two definite results. It reduces the amount of returned merchandise due to infestation and it reduces the loss of sales due to consumers finding merchandise in an infested condition.



Development of sheets for smokestack connection

PRACTICAL PLATE DEVELOPMENT—IX

Smokestack Connection Piece

By George M. Davies

The smokestack connection piece as illustrated in Figs. 74 and 75 consists of a double-angle pipe connection with a wash-boiler shaped connection piece. To develop the double-angle pipe connection as shown by section *A* and *B*, it is first necessary to obtain the miter line between the two sections.

For convenience, all lines are taken as the neutral line of the plate thickness and all diameters as the neutral diameters of the pipe and connection piece.

Draw the center lines of the connection piece in the elevation and plain views, as *A-B-C* in the elevation, and *A'-B'-C'* in the plan view. Then each side of the center lines *A-B-C* and *A'-B'-C'* step off a distance equal to one-half the diameter of the pipe and draw lines through the points parallel to the center lines, these lines representing the sides of the pipe. The method of laying out the intersection lines of the pipe in the elevation and plan views will be explained later.

Miter Line Between A and B

On the elevation, Fig. 74, draw a line through the point *C* parallel to the center line *A-B* and at *B* drop a perpendicular to *A-B*, cutting the line just drawn at *G*. Then extend *A'-B'* of the plan and at any point as *B°* in Fig. 78, step off on the center line *A'-B'*, the distance *B°-G'* equal to *B-G* of the elevation, Fig. 74. At *G'*. Fig. 78, erect a perpendicular. Then parallel to *A'-B'* of the plan, Fig. 75, draw a line through the point *C'*, Fig. 75, cutting the perpendicular just drawn at *G'*, locating the point *C°*, Fig. 78.

Next draw the line *A"-B"*, Fig. 77, parallel to *A'-B'*, Fig. 75, and extend same; then draw a line through the point *C'*, Fig. 75, perpendicular to the line *A'-B'* cutting the line *A"-B"*, Fig. 77, at *B°*. Extend the perpendicular just drawn and from *B°* step off the distance *B°-C"* equal to *B°-C°*, Fig. 78. Connect the points *B"-C"*, Fig. 77. The center lines *A"-B"-C"* form the true angle of the connection between the sections *A* and *B*. Each side of the center lines *A"-B"-C"* step off a distance equal to one-half the diameter of the pipe, and draw lines through these points parallel to the center lines, these lines representing the sides of the pipe. Where these lines just drawn intersect each other locates the points *E* and *F*. Draw the line *E-F* which will be the miter line of the sections *A* and *B*.

Intersections for Connection A

At *B°* Fig. 78, draw the profile as shown. Starting on the center line *B°-C°* divide the profile into any number of equal parts, twelve being taken in this case; the greater the number of equal parts taken the more accurate the final development. Number the points from 1 to 12. Parallel to *B°-A'-B'* draw lines through the points 1 to 12 and extend them into the plan view cutting the line *H-K'*, number the points from 1' to 12' as shown.

Next on the center line *A"-B"*, draw the half profile, Fig. 79, and divide it into six equal parts. Number the points from 1 to 12 as shown; then parallel to *A"-B"* draw lines through the points 1 to 12, Fig. 79, extending them, cutting the line *E-F*, Fig. 77.

Erect a perendicular to the center line *A'-B'*, Fig. 75, passing through the point 1' on the line *H-K*, Fig. 75 and cutting the line drawn parallel to *A"-B"*, Fig. 77, through the point 1, Fig. 79, locating the point 1', Fig. 77.

In the same manner draw perpendiculars through the points 2' to 12' on *H-K* cutting the lines drawn through the points 2-12, Fig. 79, locating the points 2' to 12', Fig. 77. Connect the points 1' to 12' with a line, completing the projection of the line *H-K*, Fig. 75.

Where the lines drawn parallel to the center line *A"-B"* through the points 1 to 12, Fig. 79, cut the line *E-F*, number the points from 1" to 12" as shown. Drop perpendiculars to the line *A"-B"* passing through the points 1" to 12" on *E-F*, cutting the lines drawn parallel to *A'-B'*, Fig. 75, through the points 1 to 12, Fig. 78, locating the points 1" to 12", Fig. 75. Connect these points with a line completing the intersection between the pipes *A* and *B* in the plan.

Next draw *m-n* perpendicular to *B'-A'-G'* through the point *B°*. Then each side of the center line *A-B*, Fig. 74, step off the distance from the line *m-n* to the points 1 to 12, Fig. 78, locating the points 1' to 12', Fig. 74. Draw lines parallel to *A-B* through the points 1' to 12', Fig. 74.

Parallel to the line *H-K* draw lines through the points 1" to 12", Fig. 75, extending them into the elevation cutting the lines just drawn through the points 1' to 12' parallel to *A-B* locating the point 1" to 12", Fig. 74. Connect the points 1" to 12", Fig. 74, with a line, completing the intersection of the pipes *A* and *B* in the elevation.

Pattern for Section A

Draw any line through section *A* as *M-N* perpendicular to *A"-B"*, Fig. 77. Then in Fig. 81 draw any line as *M'-N'*, and on *M'-N'* step off twelve equal spaces, equal to the spaces 1-2, 2-3, 3-4 to 11-12, Fig. 78. Erect perpendiculars to *M'-N'* through each of the divisions and extend the perpendiculars each side of the line *M'-N'*.

On one side of the center line *M'-N'* step off on the first perpendicular just drawn a distance equal to the distance between the line *M-N* and the point 1", Fig. 77, locating the point 1", Fig. 81. On the opposite side of the center line *M'-N'* step off on the first perpendicular just drawn, a distance equal to the distance between the line *M-N* and the point 1′, Fig. 77 locating the point 1′, Fig. 81.

In like manner take the distances from the line *M-N* to the points 2′ to 12′ and 2″ to 12″, Fig. 77, and transpose them to Fig. 81 locating the points 2′-12′ and 2″-12″, Fig. 81. Connect the points 1′ to 12′ and 1″ to 12″ with lines completing the pattern of section *A*.

Miter Line Between C and D

Erect perpendiculars to *B-D*, Fig. 74 at *B* and *C* and on the perpendicular to point *C* set off *C′-P* equal to *B′-P′*, Fig. 75. Through *P* draw a line parallel to *B-D* cutting the perpendicular to the point *B*, Fig. 74, locating the point *B′*, Fig. 76. Connect *B′-C′*, Fig. 76. Parallel to *B-D* draw a line through point *C′*, Fig. 76. Extend *R-S* cutting the line just drawn at *D′*. Draw the line *C′-D′*.

The center lines *B′-C′-D′*, Fig. 76, form the true angle of the connection between *B* and *C*. Each side of the center line *B′-C′-D′* step off a distance equal to one-half the diameter of the pipe, and draw lines through these points parallel to the center lines, these lines representing the sides of the pipe; where these lines just drawn intersect each other locates the points *X* and *Y*. Draw the line *X-Y* which will be the miter line of the section *B* and *C*.

Intersections for Connection C

On the center line *B′-C′*, Fig. 76, draw the profile, Fig. 80, and divide it into twelve equal parts and number them from *m* to *x* as shown. Parallel to *C′-B′*, Fig. 76, draw lines through the points *m* to *x* cutting the line *X-Y*. Number these points from *m′* to *x′* as shown.

Then on the center line *B-D*, draw the profile, Fig. 80 (a) and divide it into twelve equal parts, numbered from *m* to *x* corresponding to Fig. 80. Parallel to *B-D* draw lines through the points *m* to *x* and extend them into the elevation. Then parallel to *R-S* draw a line through to point *s*, Fig. 76, cutting the line drawn through to point *s*, Fig. 80 (a), locating the point *s*, Fig. 74. In like manner draw a line through the point *r*, Fig. 76, parallel to *R-S* cutting the line drawn through the point *r*, Fig. 80 (a), locating the point *r*, Fig. 74. In like manner locate the points *s* to *x*, Fig. 74. Connect the points *m* to *x*, Fig. 74, with a line completing the connection between pipe *B* and *C* in the elevation.

Step off each side of the center line *D″-C′*, Fig. 75, distances *p″-o″*, *p″-n″*, *p″-m″*, *p″-q″*, *p″-r″*, *p″-s″* equal to their corresponding distances—each side of the center line *D′-C′*, Fig. 76. Draw lines parallel to *D″-C′* through these points.

Draw lines parallel to the line connecting the point *C*, Fig. 74, to the point *C′*, Fig. 75, through the points *m* to *x*, Fig. 74, cutting their corresponding lines drawn parallel to the line *D″-C′*, Fig. 76, locating the points *m* to *x* in Fig. 76 as shown. Connect the points *m* to *x*, Fig. 76, completing the connection line between the pipes *B* and *C* in the plan view.

Then parallel to the center line *B′-C′*, Fig. 75, draw lines through the points 1″ to 12″ cutting the intersection line between the pipes *B* and *C* and number these points from 1° to 12° as shown.

Parallel to the center line *B″-C″*, Fig. 77, draw lines through the points 1″-12″ and extend same past *C″*.

Then connect the point *C′*, Fig. 75, and *C″*, Fig. 77 and draw lines parallel to this line through the points 1° to 12°, Fig. 75, cutting their corresponding lines in Fig. 77 locating the points 1° to 12°, Fig. 77. Connect the point 1° to 12°, Fig. 77, with a line completing pipe *B* in Fig. 77. The surface lines 1″ to 1° to 12″ to 12°, Fig. 77, are shown in their true lengths.

Development of Transition Piece C

For convenience the connection piece *C* has been duplicated in Fig. 82. The plan and elevation being exactly the same as in Figs. 74 and 76.

An examination of the elevation shows that the connection piece is symmetrical about the line *A-B* and therefore a development of one-half of the connection piece is all that will be necessary, a duplicate of the half pattern obtained will complete the full pattern.

The first step is to complete the end view. Draw the half profile, Fig. 84, and divide same into any number of equal parts, six being taken in this case. Number the points from 1 to 7. Then parallel to *N-O* draw lines through the points 1 to 7 cutting the line *E-F*. Number these points from 1 to 7 as shown.

Then on the center line *A-B* draw the profile, Fig. 83, and divide the top half into the same number of equal parts as was taken in the profile, Fig. 84. Number same from 1 to 7 as shown. Draw lines parallel to A-B through the points 1 to 7, Fig. 83, and extend them through to the end view.

Next draw lines parallel to the center line *N-K* through the points 1 to 7 on the line *E-F*, cutting their corresponding lines drawn parallel to *A-B* in the elevation and end view, locating the points 1′ to 7′ of the elevation.

Then in the end view step off each side of *H-G* on the line drawn through points 3 and 5 of profile Fig. 83, a distance equal to the vertical distance from the line *J-N* to the points 3 and 5 on the line *E-F*, locating the points 3′ and 5′ in the end view. In like manner locate the points 2′ and 6′, 1′ and 7′. Connect the points 1′ to 7′ with a line completing the end view. Then in the end view divide the semicircle *L-H-M* into the same number of equal parts as was taken for the profile Fig. 84. Number these parts from *a* to *g* and draw lines parallel to *A-B* through the points *a* to *g* cutting the line *C-D*. Number these points from *a′* to *g′* as shown.

Connect the points 1′-*g*, 2′-*f*, 3′-*e*, 4′-*d*, 5′-*c*, 6′-*b*, 7′-*a* in the end view with solid lines and the points 2′-*g*, 3′-*f*, 4′-*e*, 5′-*d*, 6′-*c*, 7′-*b* with dotted lines and in the elevation connect the same points with solid and dotted lines. These lines represent the surface lines of the object. In order to obtain the true length of these surface lines it is necessary to make a series of right angle triangles as shown in Fig. 85 and 86.

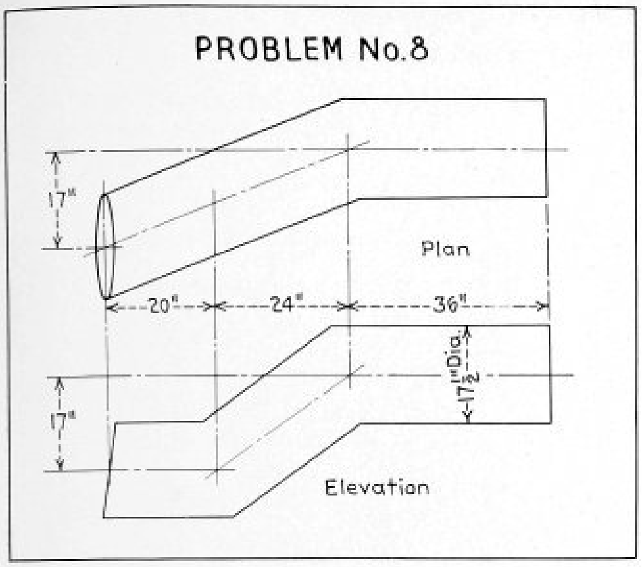
Draw any line as *m-n*, Fig. 85 and at *n* erect the perpendicular *n-o*. On *m-n* from *n* step off the distances 1′-*g*, 2′-*f*, 3′-*e*, 4′-*d*, 5′-*c*, 6′-*b*, 7′-*a* locating the points *a′* to *g′* on *m-n*. On *n-o* from *n* step off the vertical distance from the line *D-C* to the points 1′ to 7′ in the elevation locating the points 1′ to 7′ on *n-o*.

Connect to points 1′-*g′*, 2′-*f′*, 3′-*e′*, 4′-*d′*, 5′-*c′*, 6′-*b′*, 7′-*a′*. These lines will be the true length of the solid surface lines in the plan and elevation.

In like manner determine the true length of the dotted surface lines as shown in Fig. 86. The bases of the triangles being taken equal to 2′-*g*, 3′-*f*, 4′-*e*, 5′-*d*, 6′-*c*, 7′-*b* of the end view and the altitudes being taken equal to the vertical distance between the line *C-D* and the points 2′ to 7′ of the elevation.

Pattern for Section C

To construct the pattern of Section *C* draw any line *P-Q* as shown in Fig. 87 and step off the distance *a′-h* equal to *a′-h* of the elevation. Then with *h* as a center and with the dividers set equal to *h*-7′ of the elevation, scribe an arc. Then with the dividers set equal to *a′*-7′,



Problem No. 8, for Readers to Lay Out

The solution of this problem will appear in the February issue

Fig. 85, scribe an arc cutting the arc just drawn locating the points 7′, Fig. 87.

Next with *a*′, Fig. 87, as a center and with the dividers set equal to the distance *a-b* of the end view scribe an arc; then with 7′, Fig. 87, as a center and with the dividers set equal to 7′-b, Fig. 86, scribe an arc cutting the arc just drawn locating the point *b*′, Fig. 87.

Then with 7′, Fig. 87, as a center and with the dividers set equal to 7-6, Fig. 84, scribe an arc, and with *b*′, Fig. 87, as a center and with the dividers set equal to *b*′-6′, Fig. 85, scribe an arc cutting the arc just drawn, locating the point 6′, Fig. 87. Continue in this manner to 1′-*g*′, Fig. 87, making *b*′-*c*′, *c*′-*d*′, *d*′-*e*′, *e*′-*f*′, *f*-*g*′ of Fig. 87 equal to *b-c*, *c-d*, *d-e*, *e-f*, *f-g* of the end view and 6′-5′, 5′-4′, 4′-3′, 2′-1′ equal to 6-5, 5-4, 4-3, 3-2, 2-1, of Fig. 84. The length of the solid and dotted surface lines are taken from their corresponding length in Figs. 85 and 86.

Then with *g*′, Fig. 87, as a center and with the dividers set equal to *g*′-*h* of the elevation, scribe an arc and with 1′, Fig. 87, as a center and with the dividers set equal to 1′-*g*′ of the elevation, scribe an arc cutting the arc just drawn locating the point *h*′, Fig. 87.

Connect all points as shown, completing the half pattern of section C.

Pattern for Section B

Draw any line through section *B* as *V-W* perpendicular to *B*″-*C*″, Fig. 77.

Then in Fig. 88, draw any line as *V*′-*W*′ and on *V*′-*W*′ step off twelve equal spaces, equal to the spaces 1-2, 2-3, 3-4 to 11-12, Fig. 78. Erect perpendiculars to *V*′-*W*′ through each of the divisions and extend the perpendiculars each side of the line *V*′-*W*′.

On one side of the center line *V*′-*W*′ step off on the first perpendicular just drawn a distance equal to the distance between the line *V-W* and the point 1″, Fig. 77, locating the point 1″, Fig. 88, and on the opposite side of the center line *V*′-*W*′ step off on the first perpendicular just drawn, a distance equal to the distance between the line *V-W* and the point 1°, Fig. 77, locating the point 1°, Fig. 88.

Note: Space did not permit publication of the solution to Practice Problem No. 6 in this issue. It will appear in the January number.

In like manner take the distances from the line *V-W* to the points 2″ to 12″ and 2° to 12°, Fig. 77, and transpose same into Fig. 88 locating the points 2″ to 12″ and 2° to 12°, Fig. 88. Connect the points 1″ to 12″ and 1° to 12° with lines completing the pattern for section B.

(To be continued)

Vessels Subject to External Pressure

By William D. Halsey

In the 1934 edition of the A.S.M.E. Code for Unfired Pressure Vessels, new rules are given for the design of cylindrical vessels subjected to external pressure. The code makes available in workable form a composite of information which long had been desired by designers of such equipment. The Hartford Steam Boiler Inspection and Insurance Company took an active part on the special research committee that prepared this material. With the publication of the rules, the company has announced its adoption of them as its recommended standard for the calculation of allowable pressures for such vessels. A summarized discussion of the principles involved may enable owners of such equipment to understand better the problems of safe design in a class of vessel that is in more or less common use among process industries.

The behavior of a vessel under external pressure is different, in many respects, from its behavior under internal pressure. Internal pressure results, for the most part, in tensile stress and the vessel tends to change to a shape of greater strength, that is, it seeks to become a sphere. On the other hand, a vessel under external pressure tends to change to a weaker shape. As the change in shape occurs, its ability to withstand the external pressure is very much reduced, and failure will occur at a pressure very much less than the vessel could safely withstand in its original form.

The action of vessels under either internal or external pressure may be compared to the action of test specimens of steel under tensile stress or under compression. The material in the shell of a vessel under internal pressure acts in much the same manner as a specimen under tension. A vessel under external pressure acts in a manner quite similar to a specimen under compression. This comparison may be carried a little further by considering the action of long and short columns under compression. Columns in which the thickness or diameter is small, as compared with the length, will, under compression, tend to bend easily. Some bending may take place before the stresses reach the yield point or elastic limit of the material. If the load is removed, when a certain amount of deflection has occurred and before the yield point of the material is reached, the specimen will return or spring back to its original condition. However, when the specimen bends, it immediately loses strength, it very soon passes the yield point because of the change in shape, and the continued application of the load causes it to fail. Columns which have a large thickness or diameter as compared to their length will not bend under a compressive load but will upset or change shape by increasing in diameter or cross section.

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A column in which the thickness or diameter is small as compared with the length is said to fail by instability. On the other hand, a column that has a large diameter as compared with the length is said to fail by yielding. Pressure vessels under external pressure may fail in either of these ways.

The ratios of plate thickness to diameter and also length of cylinder to diameter are very important in the analysis of vessels subject to external pressure. Vessels with walls that are relatively thin as compared to the shell diameter change shape readily under external pressure and, by such action, become weaker and deflect still further from the original shape. However, until actual permanent change in shape takes place, the stresses in the material do not reach the yield point. Such vessels are said to fail by instability. Other vessels which have walls that are relatively thick as compared with the shell diameter do not lose strength until the stress in the metal reaches the yield point. They then start to deflect and thus become progressively weaker.

Calculating Yield Strength

The yield strength of a short thick column is easy to calculate, it being simply a matter of dividing the load by the cross sectional area of the specimen. It is also easy to calculate the strength of a vessel that will fail by yielding, as the computation is the same as that used for vessels under internal pressure. However, just as the strength of a slender column depends upon both its length and its cross sectional dimensions, so also does the strength of a vessel, that has a thickness small in comparison with its diameter, depend upon its length, thickness, diameter, and, of course, upon the physical properties of the material.

The heads of a cylindrical vessel under external pressure, by maintaining the circular shape of the vessel at its ends, tend also to strengthen the entire structure. Therefore, the distance between the heads, or supporting rings, of a vessel enters into the determination of its strength. On the other hand, when the length of a vessel reaches a certain value the heads no longer help support the middle portion, so that the collapsing pressure remains unchanged for any further increase in length.

Rules Apply to Mild Steel

The calculation of vessels under external pressure involves some very complex mathematics and the details of this will not be treated here but may be obtained in the code itself. The new rules for external pressures in the code relate only to vessels built of ordinary boiler steel or materials having practically the same physical properties. Furthermore, these rules relate only to plain cylindrical vessels of three general classes: (1) The plain cylindrical vessel such as the vacuum tank, the external pressure being that of the atmosphere; (2) the typical cylindrical jacketed vessel or autoclave, and (3) the double cylindrical jacketed vessel, such as a fat melter in the packing industry. The last two classes are subjected usually to steam pressure from the outside.

In a vessel under external pressure, one that is perfectly cylindrical will be stronger than one of eccentric shape. However, since it is impossible from a practical standpoint to construct a vessel that is perfectly cylindrical, the code gives certain tolerances or limits for variations from the true cylindrical shape. Vessels under external pressure may be strengthened by the use of reinforcing rings. Rules for the size of such rings and their permissible spacing are also given in the code. In addition, the method of supporting the vessel under external pressure is of importance, and the code gives consideration to this matter.

Impact Test of New Six-Curve Lens

A new goggle lens, having far greater impact resistance than any lens previously used in standard eye-protection equipment, is now being offered by the American Optical Company, Southbridge, Mass. The new lens, called the 6-Curve Super Armorplate, gets its extra strength from its high curvature, according to a statement issued by the manufacturer. An indication of its superior impact resistance is provided in the account of tests used to determine its strength.

Test ball at moment of impact

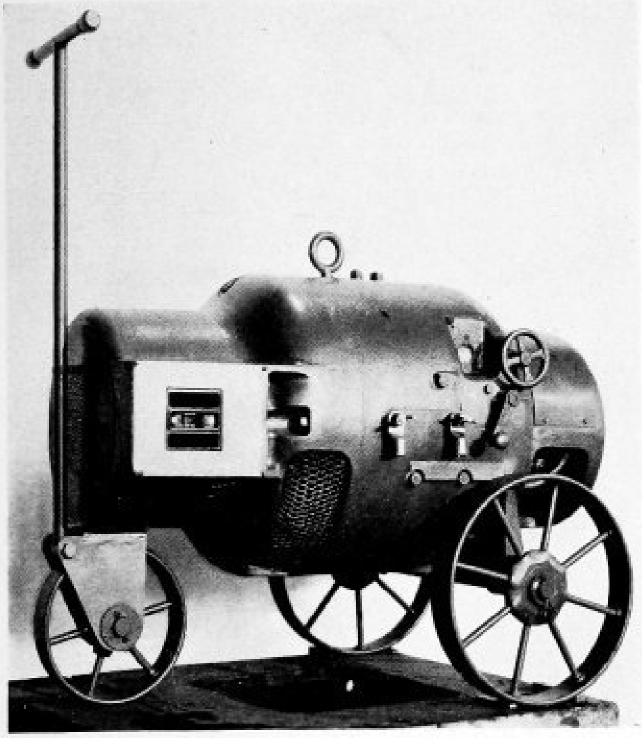
A one-inch solid steel ball was dropped on the lens from a height of 10 feet. The unretouched, stop-motion photograph reproduced here—taken by Professor H. E. Edgerton of the Massachusetts Institute of Technology—shows how the camera caught the action. This photograph, said to be the first ever taken of an impact goggle lens at the moment of impact, required an exposure of only 1/100,000 of a second. The standard test for goggle lenses specifies a ⅝-inch steel ball dropped from a height of 39 inches. A height of three times the government standard, and a weight of four times the standard was used in testing the new 6-curve lens: a blow having twelve times the energy of the standard test.

Besides its advantages in resisting impact hazards, the 6-curve lens is declared to be more effective in deflecting glancing blows, because of its higher curvature; and it is also stated that the curvature permits a closer fitting to the face without interfering with the eyelashes. In the event of fracture by an irresistible blow, tests indicate that the curvature tends to push the fragments out and away from the eye.

Oxy-Acetylene Equipment

The expenditure necessary to keep oxy-acetylene equipment in first-class condition is insignificant in comparison with the benefits resulting from adherence to such a policy. It is invariably true that plants and shops which have good equipment, maintained in good condition, are those which do the best work and save most by intelligent use of the oxy-acetylene process. Good workmen take pride in good equipment. They will do better work with tools that are in first-class condition.

Your oxy-acetylene equipment is always ready to do a job and save money for you. When it is in good condition, and kept so, it does a better job and saves more money. This is well worth your consideration.—*Oxy-Acetylene Tips.*



Westinghouse Flexarc welding set

Improved control principle applied to

ARC-WELDING GENERATOR

By J. H. Blankenbuehler*

A new control principle for arc-welding sets giving a practically constant current volt-ampere curve and excellent transient characteristics has been perfected after several years intensive engineering research. Operating on a cross-field generator scheme these sets reduce operating costs, produce consistently better welds, increase the range of electrode sizes and thickness of materials welded, are convenient to operate and are safe in operation due to low open circuit voltages. Also, because of simplicity of construction and the elimination of meters and many other parts, maintenance costs are a minimum.

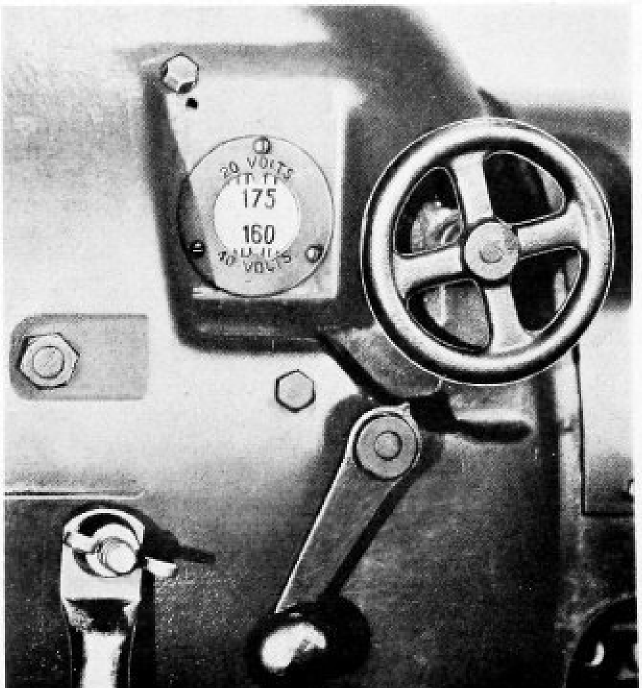
This new generator employs but few parts. It has two poles instead of four, four field coils instead of the usual 8 or 10, four brush arms instead of the usual 6 of generator and exciter. No exciter, no brush shifting devices, no reactor, no meters, no rheostat, no resistors, no pushbutton, no starter coil are used. The elimination of these parts makes possible a welding set of a clean cut type never before possible and eliminates the majority of the sources of trouble and maintenance.

Giving as it does a practically constant welding current not only on the voltampere curve but also during transient changes, this generator improves the quality of the welds and saves money three other ways.

Exclusive of overhead the cost of a weld is roughly composed of about 50 percent labor, 40 percent electrode and 10 percent electric power. Tests show even on the easiest and simplest types of welding a good constant current generator will conserve a few percent more power per pound of metal deposited than a poor one. Also, this new set has only 2 kilowatts no-load input compared to 3 to 5 for ordinary sets. Inasmuch as the set usually runs more than half of the time at no-load this decrease of no-load input alone may save enough in power to buy a new set in ten years.

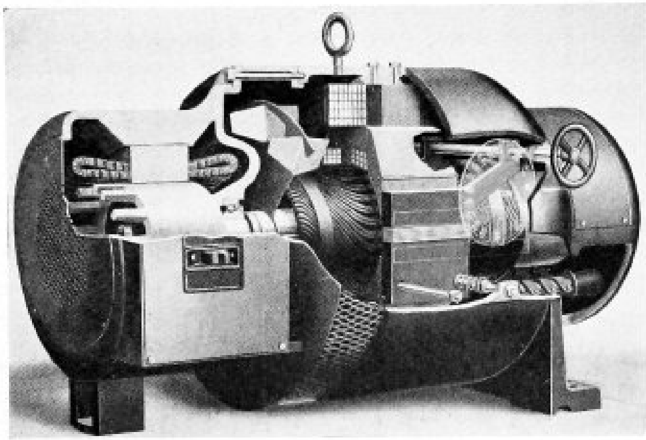
Further than this, this new constant current set puts a greater percent of the electrode melted in the weld, i.e., it gives the electrode a higher deposit efficiency. This reduces the 40 percent electrode cost.

Also because of this greater deposit efficiency and because the arc is so much easier to hold in difficult cir-



Dial showing current preset and handwheel for adjustment

* Industrial Motor Engineering, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.



Cutaway view of cross field welding generator

cumstances the operator is able to weld faster thus reducing the 50 percent labor cost. This all reduces the cost of welding, exclusive of overload, as much as 25 percent.

The new generator has an all-mechanical current control. A hand wheel on the side of the set is turned to adjust for any desired current, and the current for which the machine is set is indicated by a large seven-inch diameter dial geared to the hand wheel. This dial is mounted inside the generator frame and is visible through a glass window in the frame which is recessed into the frame so as to be protected from damage.

This type of control, with its current indicating dial, enables the operator to adjust the generator for the desired welding current without the trial and error method usually used, and renders unnecessary the delicate and usually inoperative meters which the welding operator cannot read while welding.

Also built into the side of the generator frame is a polarity reversing switch for reversing instantly the relative polarity of the electrode and ground leads, as required by different electrodes. All self-excited welding generators have in the past had a tendency to reverse their polarity frequently during use. This trouble has been eliminated in this generator.

This generator has the peculiar characteristic of being unaffected by changes in speed. This feature means that the welding operator will not notice fluctuations in the supply line.

The set has an exceptionally wide range of current adjustment. For instance it is possible to use either $\frac{1}{16}$ or $\frac{3}{8}$-inch electrodes with a 400-ampere generator. Also the continuous mechanical current adjustment gives an infinite number of current steps, making it possible to set for precisely the welding current desired without necessity of compromise.

In the usual welder with an exciter the welding current drops off during the first hour of welding because the exciter heats up reducing its voltage, and the generator field and armature and reactor coils heat up further reducing the output. This generator having no exciter, reactor or separately excited field coils has much less current drop during the warming up period, thus requiring less connective adjustment of the arc current.

The usual magnetic starter with its pushbutton has been replaced by a No-fuse circuit breaker. In addition to the usual thermal overload protection, this breaker also gives a short circuit protection. It has non-welding silver graphite contacts, and cannot accidentally jolt closed during set movement.

The ventilating fans are protected by expanded metal covers cast into the frame, which cannot be accidentally left off thus exposing the blower to damage and as a source of accident.

The set is equipped when required, with a sturdy three-wheel running gear. The combination gives an exceptionally low center of gravity with the shortest possible turning radius.

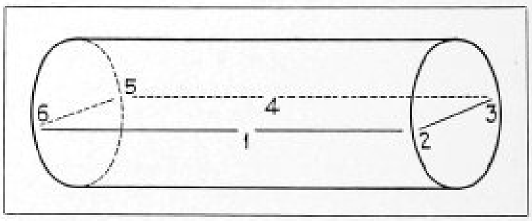
The alternating-current motor is the standard Westinghouse CS with diecast rotor and double impregnated stator with individually taped coils. The direct current motor is the standard Westinghouse SK.

Hints for Gas Cutting

There are many ideas in connection with ordinary demolition work, developed largely through experience, which will make the job easier, quicker and safer for the operators.

The first thing to consider when it is necessary to work on a tank or container that has been in use, is the matter of cleaning it out thoroughly before applying any source of heat or sparks whatsoever. Be sure that it is thoroughly clean so that no volatile materials are present inside it. Where steam is available, this may be used to remove materials which are easily volatile. Washing with strong caustic soda solution will remove heavier oils. Even after thorough cleansing, the container should, wherever possible, be filled with water before any welding or cutting or other hot work operation is performed. Keep the tank in such a position that it can be filled with water to within a few inches of the points where the cutting work is to be done. Also make sure that there is a vent or opening to provide for the release of heated air from inside the container. Open the bung hole, hand hole or other fitting which is above the water level.

Where alteration or scrapping of large containers is taking place, particularly those that have held volatile substances, periodic examination of the air contents of



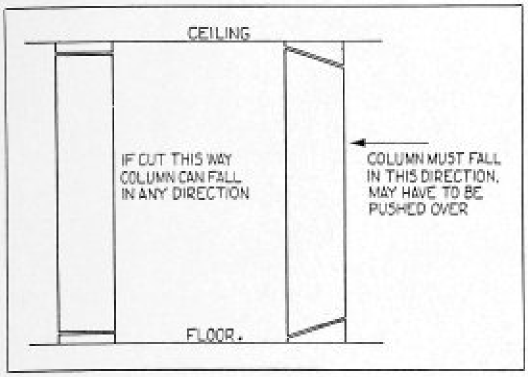
Gas cutting a tank

the vessel should be made from time to time. This is best done by means of a gas detector where such an instrument is available. Although the vessel may have been steamed and flushed with soda, there may still be traces of oil or grease under the seams. The heat of the welding or cutting operation may cause such oil or grease to give off harmful vapor to the extent that an explosive mixture may be formed inside of the tank. If possible, keep a supply of carbon dioxide in the vessel until it is thoroughly opened up and sectioned. The use of carbon tetrachloride for this purpose is not recommended because carbon tetrachloride gives off a poisonous vapor when heated.

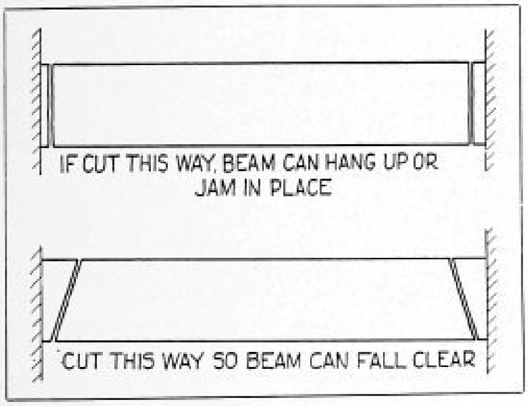
When the cleaning and ventilating is thoroughly taken care of, the work can be started with assurance that it will go through without any unforeseen occurrence.

Cutting long, round or cylindrical tanks into halves or quarters is not unusual.

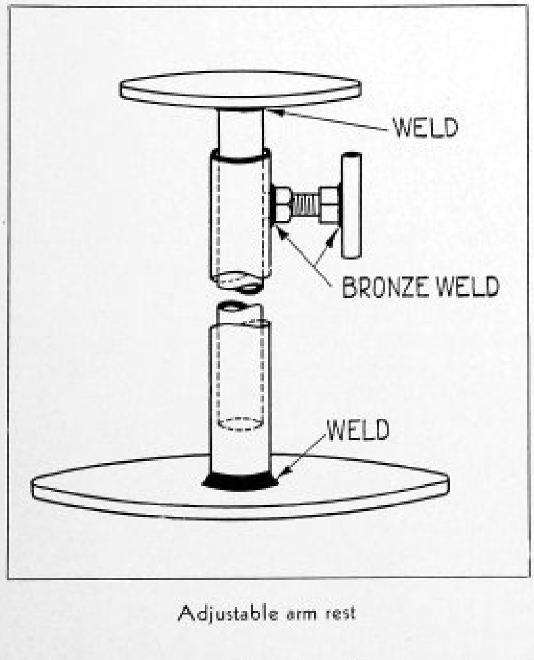
Cut around the tank as shown, but leave short uncut sections at each corner and one in the center of each side. Then cut the section in the body of the tank marked 1. Next cut away two of the corners, such as at the points marked 2 and 3. The small section at point 4 on the far horizontal side is then cut. The two corners, 5 and 6, at the far end of the tank still remain to be cut. If collapse of the tank now takes place, it will occur in front of the operator and there is little likelihood of any whipping back. The tank must fall or whip at the weakest point which is the section already cut clear and probably sagging.



Cutting upright column



Horizontal beam cutting



Adjustable arm rest

If the operator were to start at one point and continue all the way around without interruption, a time would come when the releasing of the stresses in the vessel would cause one part of the tank to move. If the tank should move the wrong way when this happens, the operator's hand or blow pipe might get caught. But by leaving small sections uncut until the last thing, the operator can do the job quite safely. The method is indicated in the accompanying sketch.

In the cutting out of upright columns, the ordinary method of doing this would seem to be to cut straight across the beam section just below the ceiling and just above the floor. Undoubtedly many who have done this work appreciate the fact that by cutting out a beam in this fashion, it can fall in any direction. Suppose the cuts at both the top and the bottom of the section are made at an angle, so that the section of the column which is to be removed somewhat resembles an elongated wedge. It is obvious that it can then fall only in one direction. This is the safest and best method from a removal standpoint.

Similarly the same reasoning can be applied to the removal of horizontal cross beams. Cutting in the ordinary fashion at right angles to the length of the beam permits it to fall at a slight angle and hang-up or lock in place. By applying the method described for upright columns, at a slight angle at each end, the beam must fall clear. There will therefore be no chance for its hanging-up.

In removing rivets from the bottom plates of a ship, and in the case of large tanks the operator has to crouch or sit on a box. In any event, he is in a cramped position, with a continual strain on the one hand that holds the blowpipe. As a result the job is a difficult one, largely due to the fatigue of the operator, poor light, inability to see the rivets and "shamrocks" on the plate. ("Shamrock" is a term used for a marred rivet hole, that is, where the plate as well as the rivet is cut.) The following suggestion will alleviate these difficulties to a considerable extent and merits the attention of repair yards.

In the first place the use of the low velocity rivet cutting nozzle will facilitate considerably the removal of rivets without damaging the plate. In addition the arm rest next described will further simplify the work.

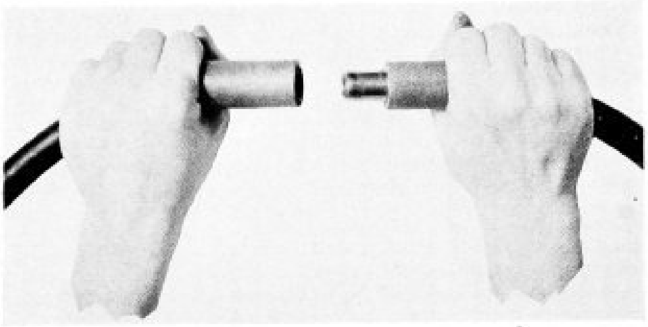
The idea involves little material or labor. It is simply an adjustable arm-rest on which the operator rests his elbow. It saves arm strain and allows him to keep his body, particularly his legs and feet, a good distance from the fall of sparks and the slag. It is a very simple thing to make from scrap material.

Cut a piece of 3/16-inch or 1/4-inch plate, round or square, say 12 inches in diameter. At the center of this, weld on a piece of 1-inch pipe, perhaps 2 feet long. About 4 inches from the free end of this pipe, cut a hole slightly larger than that in a 1/2-inch or 5/8-inch nut. Steel fusion weld or bronze-weld this nut to the pipe. Put a pointed end bolt in it while welding in order to protect the thread of the nut. Then weld to the bolt head a small piece of welding rod, thus making a handle. Now cut another piece of plate of the same thickness, say 7 inches in diameter and to the center of this weld a piece of 1/2-inch pipe, 2 feet long. This will slip into the larger pipe and can be set at the desired height by screwing in the bolt. This bolt will bite into the smaller of the two pieces of the pipe. The completed job would look somewhat like the sketch.

The operator now has an arm-rest that will save his energy and help him and eliminate "shamrocks."—*Oxy-Acetylene Tips.*

Quick-Detachable Cable Connector

A new type of quick-detachable connector, designed for use in connecting welding or electrode cable and which locks in position and cannot work loose nor be



Lincoln Cable Connector

accidentally pulled apart, is announced by The Lincoln Electric Company, Cleveland.

This new connector, as illustrated, provides the quickest method of connecting cables. Its operation is so simple that a connection can be made in the dark.

In operating the connector, the plug is inserted in the jack and a twist of the wrist locks the connection. To disconnect, the procedure is reversed.

Protection against grounding is assured by fiber insulating sleeves. It is fully described in a new bulletin on arc welding supplies, which is available on request.

Proposed Qualifying Tests for Welders

In the development of fusion welding applications, progress has been made only by offering to the user definite assurance of the integrity of the welds. The most positive determination for this is, of course, the non-destructive exploration or test of the welded joint, but where that form of test does not appear to be warranted, the plan of qualifying the welding operator by tests of welds made by him is, by common consent, regarded as the most effective safeguard for weld quality.

A committee of the American Welding Society has been appointed to correlate the requirements of existing codes relating to tests of welding operators. It is now well established that a welding operator will normally be inclined to perform welding of a quality as good as his training and ability permit for any particular process and type of filler metal. One of the difficulties most commonly encountered in establishing suitable qualification tests for welding operators is the fact that all such tests of operators are to a greater or lesser extent tests of the welding process as well.

It has, therefore, seemed advisable to divide the code into two parts as follows:

Part I—Qualification of the welding process and procedure for any group of materials and conditions.

Part II—Testing of the welding operator to determine his ability to properly apply the above qualified process and procedure.

The committee is now engaged in the important and difficult task of providing under Part I for adequate methods of qualifying the various fusion welding processes and procedures, but at this stage of its work the rules will be limited to the welding of ferrous materials, principally the non-alloy steels that have a carbon content not exceeding 0.35 percent. Effort has been made to provide tests that will be sufficiently critical to determine the ability of any welding process and procedure adequately to meet the requirements of any code or welding specification that may be involved. It is the intent of these rules to provide that the tests covered by Part I shall constitute merely an initial qualification of the process and will not require repetition if the conditions involved are not changed.

With the qualification of the process established as provided for in Part I it will be the intent of these rules that welding operators who are to operate thereunder need only submit to a very brief and inexpensive set of check tests, the purpose of which is to determine their ability to satisfactorily apply the established process. Great pains have been taken to remove from this phase of the qualification procedure, any tests that may be considered tests of the process rather than of the operator. The advantage of this plan in saving of both time and expense can be readily appreciated. The result will be more adequate treatment in Part I of the welding process in general, and at the same time, brief, inexpensive yet decisive check tests of the welding operators to determine his ability to apply the process in question. The committee expects, in the near future, to submit the proposed procedure as a tentative set of rules for publication, whereupon general criticisms thereof will be invited.

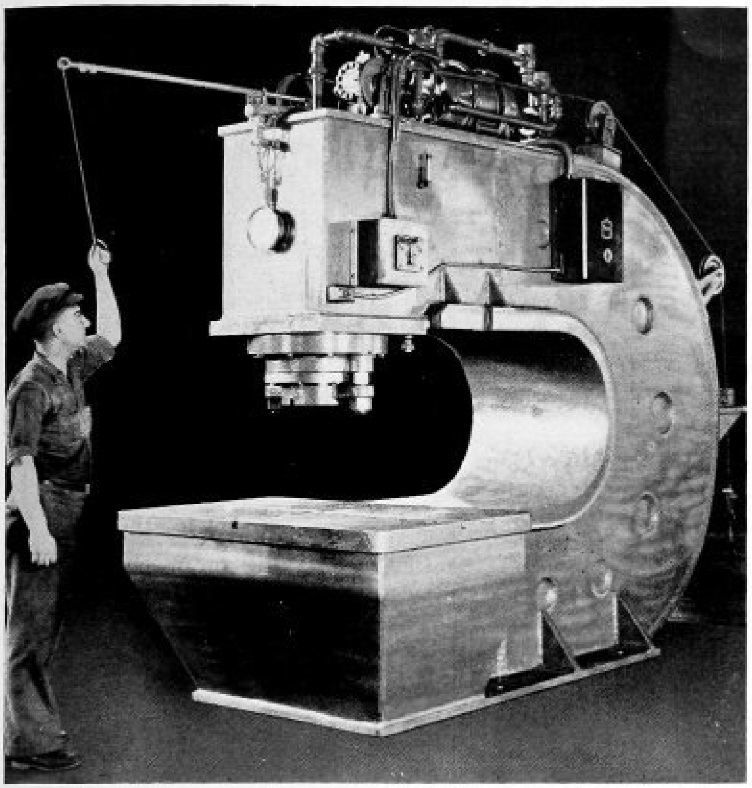
High Pressure Boilers

The question is often asked by those interested in boiler work, on what vessels and shore plants are installed boilers operating at the higher pressures.

It is probable that the installation of Benson boilers on the German merchant vessel *Potsdam* of 1500 pounds pressure, using superheated steam at 900 degrees F., is the highest actual pressure in operation for a vessel of any size. There may be some smaller experimental installations of higher pressure as there has been considerable activity along these lines in Europe. Various small boilers for steam carriages and locomotives have been operated at pressures approaching 1000 pounds.

There are numerous power plants in the United States with pressures of 1400 to 1800 pounds per square inch. There is an experimental drumless boiler at Purdue University built by the Babcock & Wilcox Company which can operate at any pressure up to 3500 pounds. This boiler has been in operation for several years, being used for experimental purposes and for securing data in connection with high-pressure steam.

While there have been various propositions outlined for boilers to be installed in contemplated United States vessels for pressures up to 1500 pounds, these, so far, have not reached the stage of actual construction. The Navy has some boilers of 450 pounds under way and there are a considerable number of United States merchant vessels with pressures between 400 and 450 pounds.



Arc-welded press of 200,000 pounds capacity

HYDRAULIC PRESS

Welded frame saves 12,000 pounds weight

The Denison Engineering Company, manufacturing engineers of Delaware and Columbus, O., recently designed and built a 100-ton hydraulic press which is installed in an eastern plant where it is used for straightening shear blades, steel plates, and the like.

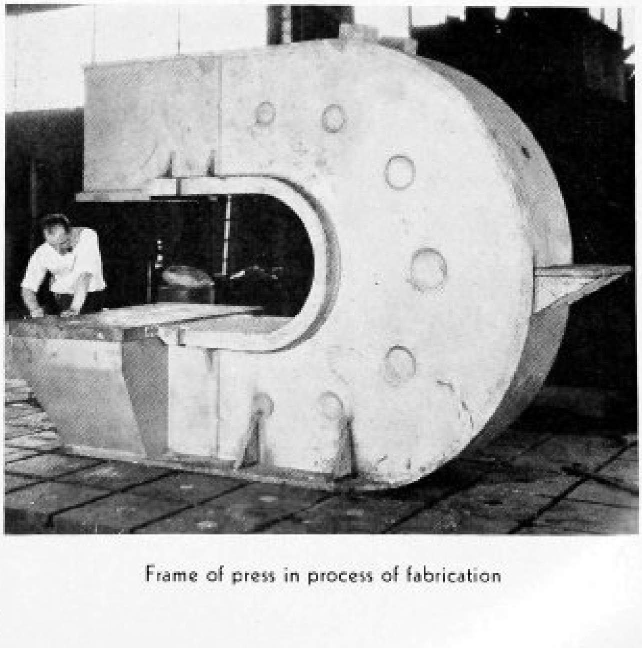
The maximum piston movement of the press is 17 inches, with a speed of 8 inches in two seconds at low pressure, and at variable speeds up to 1 inch in two seconds at high pressure. The throat is 5 feet in depth from the center of the ram to the rear of the throat, while the throat opening is 28 inches high, and the daylight opening 16 inches. Both the press plunger and the lower platen are cross-key-wayed and provided with threaded holes for affixing and alining straightening or forming dies. The press is capable of exerting a maximum pressure of 200,000 pounds.

The press is equipped with a welded steel frame, designed and built by Lukenweld, Inc., Coatesville, Pa., from a special analysis of welding quality steel supplied by Lukens Steel Company. Welding was done with covered electrodes and under insurance welding control. Before shipment, the welded structure was thoroughly furnace-annealed to eliminate any stresses which may have been introduced in the welding process.

The top platen measures 24 inches in width, 25½ inches in length and was flame-cut from a 2½-inch steel plate. The bottom platen, measuring 60 inches by 36 inches, was flame-cut from a steel plate 3 inches in thickness. The throat member was formed from a steel plate 4 inches thick. The main webs and the rear flange are steel plates 1¼ inches in thickness. The interior stiffening members are ⅝-inch steel plates, spaced on 45-degree angles from the center of the throat radius. The lower platen is substantially braced in all directions.

In the upper portion of the frame is a built-in oil reservoir containing the hydraulic oil supply. The hydraulic cylinder is fitted into the interior portion of the frame at the extreme upper front. The motor-driven hydraulic pump, together with the relief valves, by-passes and other auxiliaries, is mounted directly on top of the frame. The construction provides a self-contained unit, operation being effected by merely connecting to a power supply. This feature, in conjunction with the comparatively light weight of the complete press, provides a high degree of mobility in the unit.

The welded steel frame weighed only 15,400 pounds as shipped from the welding plant. The complete press weighs 23,000 pounds. Since it is estimated that the same press with a cast frame would have a minimum weight of approximately 35,000 pounds, the saving in weight effected through the use of welded steel construction may be estimated at 12,000 pounds.



Frame of press in process of fabrication

Velox Boiler for Locomotives

The Velox steam generator, several interesting installations of which have lately been made in Europe (actually 21 Velox generators for an average total steam output of 25 tons per hour per unit are now in operation or nearing completion), also appears likely to become an interesting factor in locomotive evolution. One of its chief advantages in this connection is that it enables the plant for a big output to be arranged in a restricted space.

The authorities of some of the leading railroad systems of France and Germany have decided to try out the Velox and have asked for designs. The drawings prepared show the proposed design of an express locomotive of 3000 horsepower for a speed of 100 miles per hour. The small dimensions of the Velox generator permit the driver's cab to be placed so that the driver gets an unimpeded view forward. The boiler, with its auxiliaries, is installed in a machine room allowing ample space for inspection. British railroads are also interested in the adaptation of this generator for locomotive service.

A Tube Welding Episode

By James F. Hobart

"I got a job as welder in the Big Four shops at Beech Grove, near Indianapolis, before the war," said the automobile mechanic, as he warmed his fingers over the blacksmith's fire. "The foreman took me into the shop and said that in a couple of weeks, or at the end of the month, he would give me the third fire, as the man there was no good and was to be dropped. The foreman said he wanted me to work as a helper on the tube-welding machine and that he would pay welder wages, and it was nobody's business that I was there temporarily."

I determined to know nothing about the job save what I was told, but the minute I walked into the shop and heard the roar of the big superheater furnace, burning crude oil, I knew the fire was not right and that it was getting too much air and not enough oil.

You see, if a draft of compressed air hits a piece of steel at a welding temperature, it will cut that steel as badly as with a cutting torch. I said nothing but went to work and the old man on the machine had nearly half the tubes sent back to him from the testing machine. One day, when the month was nearly gone, and I expected to be transferred to the third fire, I asked to be allowed to weld a few tubes, and upon assuring the machine operator that I could weld one, he allowed me to try. There was a Hart machine next to the furnace, but it was not in use. The welder said the machine always left a bunch in the tube which would not go through the holes in the tube sheet of the boilers, so they used a hammer machine adjoining the roll welder.

When I got permission to weld a tube, I told the operator that he was the helper now, and to get over into the helper's place and not to bother me with orders or suggestions. Then I stepped behind the furnace and turned on some more oil and cut the air down a little. Later, I let in a bit more air, and after the furnace had run thus for a few minutes, I told the "helper-boss" to heat up a tube. He placed it in the furnace, rubbed his eyes and said:—"Can you see that tube?" I assured him that I could, but he could see nothing of it and said there was too much oil turned on.

When the tube was heated just right, it was brought out and the "helper-boss" started to sprinkle welding compound on the hot tube, but I stopped him and told him to "get back into the helper's place." He protested and said the weld could not be made without compound, but I put it into the machine, finished the weld and slid the tube along to the tester, who looked it all over, and threw it on the pile of good tubes, saying: "That will hold all right!" Then the test man said: "I knew that weld would be a good one as soon as I heard that old furnace begin to roar as it has not roared before for 18 months, since this welder came here."

I soon went to fire No. 3, but was eventually transferred back to the tube-welder and I set the old Hart machine and welded the tubes on that. It is a bit troublesome to set a Hart machine. There are slightly concave rollers and a swelled place in the mandrel which goes inside the tube. When the machine is properly set the swelled place in the mandrel will come exactly against the hollow place in each roll and they will not mark the tube the least or leave any enlargement or extra thickness in the metal to prevent the tubes from sliding through the holes in the tube sheet.

New Boilers for Canada

An order has recently been placed with the English Steel Corporation for six solid-forged boiler drums for two boilers which are to be installed at the Ford plant at Walkerville, Ontario. These boilers are the first of their type to be erected in Canada. The required quick delivery of this order has been made possible as a result of the recent modernization of the steel-melting, forging, heat treatment, and machining plant at the Vickers Works of the Corporation in Sheffield, England. This modernization was undertaken largely as a result of the steady growth of demand for solid-forged boiler drums.

Philippines Offers Boiler Market

The United States enjoys a premier position in the supply of boilers and boiler plates to the Philippine Islands. While this is not a very extensive market in comparison to others, it is one that merits the attention of manufacturers, for there is a fairly regular demand for such equipment. The Philippine Islands are not highly industrial, and their main industries calling for boilers are the sugar mills, tobacco plants, small rice mills, saw mills, and of more recent years, mining. The larger boilers are used in the sugar industry, and the others are, for the most part, in the smaller sizes.

There are several American engineering shops in Manila, well equipped and capable of doing most repair work. Most of the boilers are imported, very little in this way being done locally. Business in machinery is usually transacted in the following manner: Suppliers in the United States appoint foreign importing houses established in Manila as their agents, and they sell direct to users. There are not many Philippino or Chinese importers of machinery, though there are a number of

Chinese distributors and dealers in hardware, who also handle machinery.

There is no such definite intermediary in the Philippines as the jobber found in the United States, for the country is too small for that and the importer takes his place. The ordinary old-fashioned firm in Manila still carries a large number of agencies without specializing in any particular branch of machinery or equipment. Competition is not so keen and business is still done in a more leisurely manner than is current in this country. The year 1934 witnessed a substantial increase in the volume of trade in iron and steel manufactures, under which boilers, etc., are classified, imports being valued at Pesos* 17,774,867 as against Pesos 12,798,363 for 1933. Specific figures for boiler and tube importations for 1933 and 1932 are as follows:

	Year 1933	Year 1932
United States	150,533	259,905
Great Britain	1,301	11,032
Germany	5,648	9,975
Sweden	1,193	.....
Total, including others	158,712	283,014

* 1 peso = 50 cents gold.

Machinery Demand in Netherland India

The trend toward local industrialization has served to stimulate slightly the demand for industrial machinery in Netherland India during the current year, a report to the Commerce Department from its Batavia office states.

The favorable Government attitude towards the development of local industries was responsible for the establishment of a number of new industrial activities during 1935, and the formation of plans for the establishment of a number of new concerns to make manufactured goods for domestic consumption. The most important domestic industries developed during the past year have been financed from abroad with American capital playing a prominent part in this development, it was stated.

The United States occupies an important place in the machinery trade of Netherland India, the report points out, ranking as the leading supplier during the first half of this year. The value of imports from the four chief supplying countries, in the order of their importance, was as follows: United States, 1,356,000 florins; Germany, 1,120,000 florins; Holland, 654,000 florins, and Great Britain, 340,000 florins. The extent to which these four countries dominate the machinery trade of the country is indicated by the fact that the value of imports from these countries amounted to 3,470,000 florins, or 89 percent of the total value of all machinery imported during this period.

An examination of the statistics shows that United States participation in the machinery import trade was in steam boilers, steam engines and turbines, combustion engines for automobiles, pumps, petroleum and paraffin factory machinery, ice factory machinery, mining machinery and other industrial factory machinery. In these items, the American share of the trade was approximately 50 percent.

More intensive sales efforts on the part of American exporters are particularly desirable, the report points out, in the case of boilers, combustion engines and machine tools, as it is believed that such efforts would improve the position of the American machinery trade in the Netherland India market.

Changes in Byers Sales Staff

R. H. Gardner, division manager of the Washington, D. C., office of A. M. Byers Company, has been transferred to Pittsburgh, Pa., as manager of steel pipe sales; and E. L. MacWhorter, manager of the Philadelphia division, has been transferred to Washington, where he will head the combined activities of both divisions now known as the Washington division. District representatives will be maintained, as formerly, in Baltimore, Md., and Philadelphia, Pa.

Qualifying Tests for Welders

Joseph B. Weaver, director of the Department of Commerce, Bureau of Navigation and Steamboat Inspection, Washington, has sent a letter to all boiler manufacturers, as well as to members of his department in the field referring to a Bureau letter of July 12, 1935, which fixed a time limit for welding operators to pass qualifying tests as November 1, 1935. The Bureau now advises that, in view of the fact that many corporations have failed to submit test specimens for the qualifying tests, it has been decided to extend the time limit to January 1, 1936.

Shipbuilders, contractors, and manufacturers are urged to get their welding operators qualified before that date, as the Bureau will not make any further extension, and those operators who have failed to pass the qualifying tests on January 1, 1936, will not be permitted to work on marine boilers or pressure vessels after that date until they have passed the prescribed tests according to the amended rules.

District Sales Manager of Republic

Robert J. Working, district sales manager of the Republic Steel Corporation, in the Cincinnati, O., territory, has been appointed district sales manager in the Birmingham, Ala., territory, succeeding Kenneth D. Mann, who has resigned to become executive vice-president of the Truscon Steel Company. Formerly in the sales department of United Alloy Steel Company at Canton, O., Mr. Working was placed in charge of the Cincinnati, O., district office of Central Alloy Steel Corporation in 1927. Following the Republic merger in 1930 he was appointed assistant district sales manager in the Cincinnati territory, and advanced to district sales manager in 1934. Paul R. Johnston of the Cincinnati office has been appointed district sales manager in the Cincinnati territory, succeeding Mr. Working. Mr. Johnston is a native of Youngstown, O., where he entered the employ of Republic Iron & Steel Company in 1922. He served in the sales department at Youngstown and later at Cleveland, then in the Detroit, Mich., and Buffalo, N. Y., offices. He was transferred to the Cincinnati office in 1929. Charles W. East, of the Birmingham, Ala., office, has been appointed assistant manager of sales in Republic's pipe division, succeeding George E. Clifford, recently appointed district sales manager in the Los Angeles, Calif., territory.

Steel Alloys Shown at Metals Exhibit

An exhibition of modern steel alloys, selected from the products of 27 American manufacturers, opened December 2, at the Metal Products Exhibits—the permanent exhibition of metals, alloys, plastics, and metal finishes in the International Building, Rockefeller Center, New York.

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

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Contents

The exhibit, which has been assembled under the direction of Adolf Bregman, managing editor of *Metal Industry,* is designed to provide a visual catalogue of the new corrosion-resistant and high tensile-strength ferrous alloys. Each alloy is shown in the form furnished to industrial users, together with its typical applications. Comprehensive data on physical and chemical properties and micro-structure are also presented.

Among the manufacturers contributing are American Sheet and Tin Plate Company, American Stainless Steel Company, The Babcock & Wilcox Tube Company, Climax Molybdenum Company, Colonial Steel Company, The Copper Alloy Foundry Company, Driver-Harris Company, Wilbur B. Driver Company, The Duriron Company, Inc., Electro Metallurgical Company, Firth-Sterling Steel Company, Haynes Stellite Company, Hevi Duty Electric Company, International Company, Inc., Jessop Steel Company, Lebanon Steel Foundry, Ludlum Steel Company, Lukens Steel Company, Michigan Steel Castings Company, The Ohio Steel Foundry Company, Rustless Iron Corporation of America, Standard Alloy Company, Steel & Tubes, Inc., The Titanium Alloy Manufacturing Company, Vanadium Corporation of America, Westinghouse Electric and Manufacturing Company.

Extended Fins on Heating Surfaces

Extended surfaces used in connection with heating surfaces on economizers, air heaters, etc., are of more or less recent origin. More and more are they being applied in boiler work.

One of the first applications of extended surface to heat-absorbing surfaces of boilers was the cast-iron gills used on Foster superheaters. Here cast-iron rings were shrunk upon the steel boiler tube. These rings increased the surface in contact with the hot gases, thus enabling each tube to absorb more heat. They also protected the steel tube from overheating and evened out the temperature in the superheater.

Radiators for industrial heaters, and particularly for heating systems for vessels and buildings, now use extended surface on their radiator tubes. These are usually in the shape of gills or fins of thin metal (copper, aluminum or composition) which are placed radially upon the tube. These surfaces coming in contact with the air will transmit more heat than will a bare tube. Sometimes the fins are put on the tube element in the shape of a spiral strip.

Boiler tubes in furnace walls (Bailey type) also utilize extended surface by having metal strips welded to them which fill the space between the tubes and absorb heat. This is one of the features of the new Babcock & Wilcox integral boiler.

The Foster Wheeler Company has recently developed an economizer using aluminum gills which is being applied to various boilers on United States destroyers.

Iron blocks of various types and means of attachment have been applied to furnace wall tubes for the purpose of absorbing heat and as a partial protection to the tubes from overheating. This also may be considered extended surface.

Trade Publications

Blast Cleaning.—The Pangborn Corporation, Hagerstown, Md., has issued a folder describing blast cleaning and dust collecting equipment manufactured by the company. Special bulletins giving complete data on each type of equipment also are available. The present publication deals particularly with the economy, efficiency and safety of special rooms designed and equipped for blast cleaning tubes, castings and metal products of all kinds.

High Frequency Electric Tools.—The Independent Pneumatic Tool Company, Chicago, has issued "High Frequency Electric Tool" catalogue No. 60, which contains for the first time in any catalogue a complete showing of attachments for electric screw driving and nut setting. Shown on the pages of this catalogue are illustrations and specifications of the entire Thor line of high frequency electric tools, including drills, drill stands, screw drivers, nut setters, tappers and stud setters, grinders, sanders, rubbers, polishers and balancers. Also this catalogue contains a section devoted to universal electric tools, pneumatic tools and contractors' tools, of Thor manufacture, tool makers for nearly half a century.

Questions and Answers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Attaching a Steam Dome

Q.—In your May, 1935, edition of BOILER MAKER AND PLATE FABRICATOR, page 138, about attaching steam dome to boiler, you gave the efficiency of the ligament for angle of 85 degrees with $E = 1.4$ and referring to P-13-1931 edition. My copy of this edition has been lost. Would you kindly explain how to calculate efficiency E? O. G.

A.—The efficiencies for diagonal ligaments as shown on Fig. P-13 "Diagram for Determining Efficiency of Diagonal Ligaments in Order to Obtain Equivalent Longitudinal Efficiency," of the 1931 A.S.M.E. Boiler Code or Fig. P-14 of the 1934 A.S.M.E. Boiler Code, were determined by actual experiments.

The efficiency 1.4 in the May issue was obtained by enlarging the diagram and extending the curve for $\frac{P'}{D} = 4$ until same intersected the vertical line for 85 degrees.

Working Pressure in Steam Jacketed Vessel

Q.—Would you please explain through BOILER MAKER AND PLATE FABRICATOR how I might proceed to determine the allowable working pressure in the steam jacket of a vessel built in accordance with the enclosed sketch. A. R.

A.—The maximum allowable working pressure of the steam jacketed vessel, submitted with the question, as illustrated in Fig. 1, would be determined by computing the allowable working pressure on the various parts of the vessel. The least pressure obtained would be the maximum allowable working pressure for the vessel, as follows:

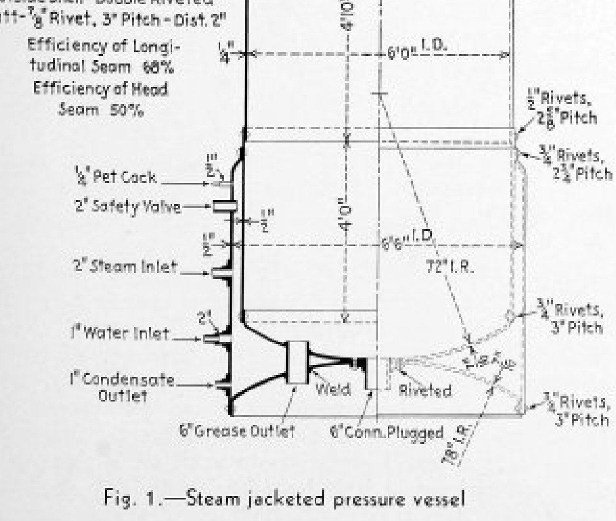


Fig. 1.—Steam jacketed pressure vessel

(1) *Outside Shell.*—The formula for computing the maximum allowable working pressure is as follows:

$$WP = \frac{TS \times t \times E}{FS \times R}$$

where, WP = maximum allowable working pressure pounds per square inch

t = minimum thickness of shell plate in weakest course, inches

E = efficiency of longitudinal joint

FS = factor of safety (5)

R = inside radius of weakest course of shell or drum, inches

TS = ultimate tensile strength, pounds per square inch, stamped on the shell plate

Substituting the values taken from Fig. 1 and assuming 55,000 pounds ultimate tensile strength, we have

$$WP = \frac{55{,}000 \times 0.5 \times 0.68}{5 \times 39}$$

$WP = 95$ pounds per square inch

(2) *Outside Head.*—The formula for computing the maximum allowable working pressure on unstayed dished heads with pressure on the concave side is as follows:

$$P = \frac{2 \times TS \times t}{8.33 \times L}$$

where, t = thickness of plate, inches

P = maximum allowable working pressure, pounds per square inch

TS = tensile strength, pounds per square inch

L = radius to which head is dished, measured on the concave side of head, inches

Substituting the values from Fig. 1 and assuming 55,000 pounds ultimate tensile strength we have

$$P = \frac{2 \times 55{,}000 \times 0.4375}{8.33 \times 78}$$

$P = 74$ pounds per square inch

Unstayed dished heads with pressure on the convex side shall have a maximum allowable working pressure equal to 60 percent of that for heads of the same dimensions with pressure on the concave side.

Thus the allowable pressure would be

$74 \times 0.60 = 44.4$ pounds per square inch

The detail of the nozzle outlets not being shown on the sketch submitted, I am assuming that same meet the requirements of the A.S.M.E. Code, otherwise the thickness of the plate used in obtaining the above working pressure would be reduced 1/8 inch.

(3) *Inside Head*.—Using the same formula as for the outside head and substituting values taken from Fig. 1 we have,

$$P = \frac{2 \times 55{,}000 \times 0.4375}{8.33 \times 72}$$

$$P = 80.2 \text{ pounds per square inch}$$

The pressure being on the concave side the allowable working pressure would be

$$80.2 \times 0.60 = 48 \text{ pounds per square inch}$$

The least allowable working pressure obtained being 44.4 pounds, this would be the working pressure for the kettle.

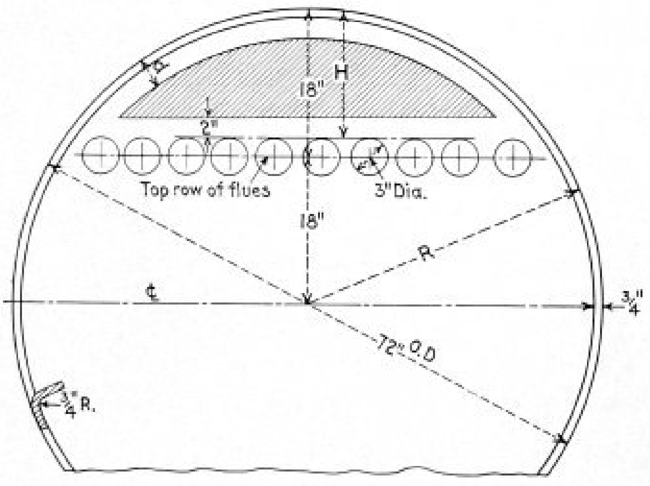
The inside shell would have to be supported by staybolts for this pressure.

Area of Segment of Head To Be Stayed

Q.—Attached is sketch of a 72-inch head and if possible please explain in detail the finding of area of segment under the rules of the Hartford Steam Boiler Inspection. E. J. M.

A.—The Hartford Steam Boiler Inspection and Insurance Company Boiler Book gives the following rules and formulas for computing the area of the segment of a head to be stayed.

1. The distance of 2 inches from the tubes where bracing is not required is taken as constant for all sizes



Finding the area of a segment

of boilers, all pressures and all head thicknesses, but the distance supported by the flange of the head (indicated by letter d in Fig. 1) is dependent upon the pressure and the thickness of the head in each case.

Values of d may be determined by the following formula:

$$d = \frac{5 \times T}{\sqrt{P}}$$

where, d = unstayed distance from shell, in inches

P = maximum allowable working pressure, in pounds per square inch

T = number of sixteenths of an inch in head thickness. ($T = 8$ for 1/2 inch head, 9 for 9/16 inch head, etc.)

The outside radius of the flange of the head may be used for d if such radius is greater than the value obtained by the formula, except that the value obtained in this manner must not be greater than eight times the thickness of the head.

2. The area of the segment to be stayed can be calculated from the formula

$$\text{Area} = \frac{4(H-d-2)^2}{3} \sqrt{\frac{2(R-d)}{(H-d-2)} - 0.608}$$

where, H = distance from top (or bottom) of tubes to shell, in inches

R = radius of the boiler head, in inches

d = unstayed distance from shell, in inches

The information given on the sketch furnished with the question is shown on Fig. 1. The sketch submitted did not include the diameter of tubes, the radius of the flange, or the working pressure. As these factors are necessary in order to illustrate the problem, I have assumed 3-inch tubes, 3/4-inch radius of flange and 150 pounds working pressure.

Substituting the values shown in Fig. 1 we have:

$$d = \frac{5 \times 12}{\sqrt{150}}$$

$$d = \frac{60}{12.2474}$$

$$d = 4.90 \text{ inches}$$

The area of the segment will then be computed as follows:

$$\text{Area} = \frac{4\,(16.5-4.9-2)^2}{3} \sqrt{\frac{2\,(36-4.9)}{(16.5-4.9-2)} - 0.608}$$

$$\text{Area} = \frac{4(9.6)^2}{3} \sqrt{\frac{62.2}{9.6} - 0.608}$$

$$\text{Area} = 122.88 \sqrt{5.871}$$

$$\text{Area} = 122.88 \times 2.42$$

$$\text{Area} = 297.37 \text{ square inches.}$$

Developing a Smoke Pipe

Q.—As a subscriber to BOILER MAKER AND PLATE FABRICATOR for a number of years, I would esteem it a great favor if you would develop a smoke pipe leading from the boiler to the smokestack. The print I am enclosing is a copy of the original print from which I had this pipe to lay out. I would appreciate the publishing of this layout as soon as possible. M. H.

A.—The method of developing the smoke-pipe leading from the boiler to the smoke stack as illustrated on the sketch submitted with the question, is shown as this month's instalment of the series on "Practical Plate Development," appearing on page 345.

Ryerson Appoints Eastern Manager

Thomas W. Delanty, who has been covering the eastern territory since 1930 for Joseph T. Ryerson & Son, Inc., Chicago, has been appointed manager of eastern railroad sales with headquarters at Jersey City, N. J. Mr. Delanty has been with the Ryerson company since 1918. He handled the export business in China and Japan for the machinery division until 1925, since which time he has been in its railroad sales division.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—John M. Hall, Washington, D. C.
Assistant Chief Inspector—J. A. Shirley, Washington.
Assistant Chief Inspector—J. B. Brown, Washington.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

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Chairman—D. S. Jacobus, New York.
Acting Secretary—M. Jurist, 29 W. 39th Street, New York.

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International Brotherhood of Boiler Makers, Welders, Iron Ship Builders and Helpers of America

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Assistant International President—J. N. Davis, Suite 522, Brotherhood Block, Kansas City, Kansas.

International Secretary-Treasurer—Chas. F. Scott, Suite 506, Brotherhood Block, Kansas City, Kansas.

Editor-Manager of Journal—L. A. Freeman, Suite 524, Brotherhood Block, Kansas City, Kansas.

International Vice-Presidents—Joseph Reed, 3753 S. E. Madison Street, Portland, Ore.; W. A. Calvin, Room 402, A. F. of L. Building, Washington, D. C.; Harry Nicholas, 6215 S. Benton Blvd., Kansas City, Mo.; W. E. Walter, 637 N. 25th Street, East St. Louis, Ill.; J. H. Gutridge, 2178 South 79th Street, W. Allis, Wis.; W. G. Pendergast, 1814 Eighth Avenue, Brooklyn, N. Y.; W. J. Coyle, 424 Third Avenue, Verdun, Montreal, Quebec, Can.; A. M. Milligan, 262 Trent Avenue, East Kildonan, Man., Can.; J. F. Schmitt, 28 S. Roys Street, Columbus, Ohio; William Williams, 1615 S. E. 27th Avenue, Portland, Ore.

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Fifth Vice-President: Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis (Big Four), 814 Big Four Building, Indianapolis, Ind.

Secretary: Albert F. Stiglmeier, general foreman boiler maker, New York Central, West Albany Shops, 29 Parkwood Street, Albany, N. Y.

Treasurer: William H. Laughridge, retired general boiler inspector, Hocking Valley R. R., 537 Linwood Avenue, Columbus, O.

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OFFICE OF INDUSTRIAL RECOVERY COMMITTEE,
15 PARK ROW, NEW YORK

Manager—James D. Andrew.
Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President — Merle J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

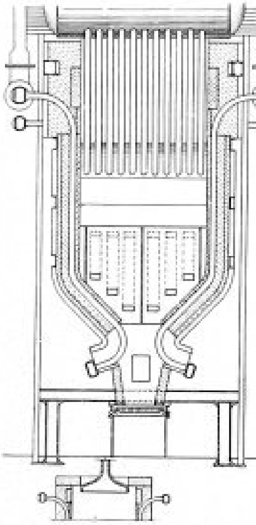
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent Attorney, 1372-1376 National Press Building, Washington, D.C. Readers wishing copies of patents or any further information regarding any patent described, should correspond directly with Mr. Galt.

1,872,972. BOILER FURNACE CONSTRUCTION. HENRY P. KIRCHNER, OF NIAGARA FALLS, NEW YORK, ASSIGNOR TO THE CARBORUNDUM COMPANY, OF NIAGARA FALLS, NEW YORK, A CORPORATION OF PENNSYLVANIA.

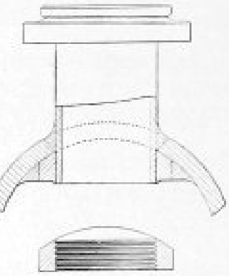
Claim.—A boiler furnace for burning powdered coal fuel at high rates of combustion and for operating the boiler at correspondingly high ratings comprising in combination a combustion chamber having front, back and side walls with silicon carbide linings for the exposed surfaces of said chamber; a burner arranged to project a sheet of flame downward from



an opening in the top of the chamber so that said sheet is initially parallel to the front and back walls, air ducts in one said of said walls for preheating air by transmission of heat from the upper portion of said sheet of flame, air inlets for the air ducts whereby the air thus preheated is admitted to the combustion chamber, another series of air ducts in the same wall for preheating air by transmission from the lower portion of the flame and delivering said air at an intermediate level in the combustion chamber, a third series of air ducts arranged in the wall opposite to the burner outlet and arranged to deliver preheated air to the lowermost portion of the combustion chamber, boiler tubes extending across the outlet of the combustion chamber above said last-mentioned air-cooled wall, other boiler tubes embedded in the side walls and extending substantially the length thereof, and means for varying the respective rates of air and water cooling. Two claims.

1,875,404. SYSTEM FOR CONNECTING BRANCH TUBES TO PRESSURE VESSELS OR PIPES. JOHN ARTHUR AITON, OF DERBY, ENGLAND, ASSIGNOR TO AITON & COMPANY LIMITED, OF DERBY, ENGLAND.

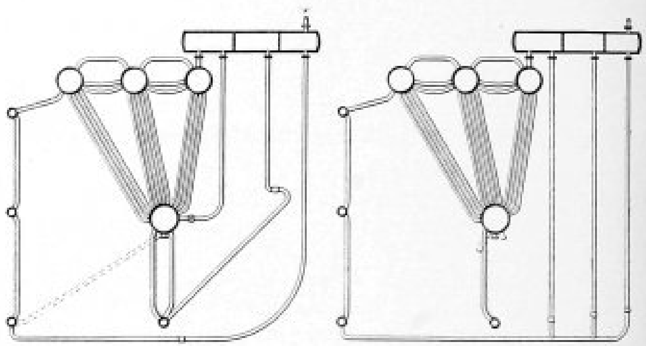
Claim.—In combination a vessel adapted to withstand pressure, a branch pipe therefrom, the said branch pipe being screwed into a nut within the



said vessel, a weld at the junction of the branch pipe with the exterior of the vessel and a weld at the junction of the nut with the interior of the vessel. Two claims.

1,887,141. BOILER INSTALLATION. WALTER SIEGERIST, OF BAYSIDE, NEW YORK, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim.—The combination with a water tube boiler of a combustion chamber therefor having a wall defined by upright boiler tubes connected



into the boiler circulation, a steam separator, a connection for leading steam from the boiler to the separator, and means for discharging moisture from the separator into the boiler comprising downcomers outside the boiler circulation for leading the moisture to the upright boiler tubes. Four claims.

Boiler Maker and Plate Fabricator

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Index to Volume 36

January to December, 1936

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INDEX

Note—Illustrated articles are marked with an (*) asterisk; Book reviews (B. R.); Communications (C); Editorials (E); Paragraphs (P); Questions and Answers (Q).

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B

C

Boiler Maker and Plate Fabricator

Locomotive Boiler Accidents Increase

In his last annual report to the Interstate Commerce Commission before retirement as chief inspector of the Bureau of Locomotive Inspection, A. G. Pack decries the seriousness of locomotive failures that occurred during the past fiscal year.

Locomotive accidents increased from 192 in 1934 to 201 in 1935; the number of persons killed increased from 7 to 29 and the number of persons injured from 223 to 267. Boiler failures accounted for 68 of the accidents in 1935 or 33.8 percent. Twenty-four persons were killed in such failures, a total amounting to 83 percent of all fatalities from locomotive disasters. About 45 percent of the total injuries received from such accidents were due to boiler failures. In his persistent campaign throughout the period of his incumbency in office to reduce locomotive failures, Mr. Pack continually stressed the need for better boiler maintenance. Crown sheet failures now as throughout the entire period in which the inspection laws have been in effect constitute the most prolific cause of fatal boiler accidents. The only safeguards against this danger are proper construction, maintenance and adequate inspection of appurtenances, and finally competent, watchful operation to assure that the water level is maintained over the crown sheet at all times.

Economic conditions during the depression years have not been conducive to the greatest measure of safety. The best demonstration of this fact is given in the tables of condition of locomotives for the past few years. With the radically curtailed traffic demands on motive power which prevailed from 1930 through 1934, it was possible for the railroads to maintain in serviceable condition the locomotives required. The means used, which depleted almost to the vanishing point the reserves of power on the railroads require no comment. It is a condition that must be corrected.

What the record shows is that the fewest accidents occurred in 1932 when the percentage of defective locomotives was at the lowest point in the history of the Bureau of Locomotive Inspection. In that year there were 145 failures which resulted in 9 killed and 156 injured. The locomotives inspected and found to be defective amounted to only 8 percent. Only 527 locomotives were ordered out of service—another all-time low mark.

With the returning traffic load and with a serious maintenance and rehabilitation program on their hands, the mechanical departments of all railroads must be everlastingly on their guard against failures. Defective locomotives and locomotives ordered out of service bear a direct relation to locomotive accidents. With the existing tendency for the former to increase, more attention must be given to improving the maintenance situation or the accident record will inevitably show an increase.

Rehabilitation must have its inception in the shops. Proper maintenance cannot be carried out with inefficient, worn out tools and equipment. The move for plant replenishment is already under way. In the same manner shop organizations must be built up with skilled, competent men in every department. Finally it is most essential that a spirit of complete co-operation exist between the railroads and the Bureau of Locomotive Inspection.

With general business improving rapidly, and recovery definitely under way for the railroads, it would seem to be essential for safety that the long deferred maintenance program be undertaken without delay.

Solving Shop Problems

A very practical value from the reader's standpoint is attached to the service of the Questions and Answers Department in this publication. The problems presented cover the entire range of boiler, plate and tank work. Answers to these questions over a period of time constitute a wealth of information that can be applied to shop problems constantly arising in the conduct of everyday work.

Evidently a realization of the possibilities in the use of this department has become apparent to some of our readers at least—as demonstrated in the current issue by the instalment of the "Practical Plate Development" series on the subject of locomotive firebox layout.

The circumstances under which this subject is being treated at length will be of general interest since it indicates how one of our oldest subscribers has taken advantage of our consulting facilities as a means of checking layout methods practised in his shop.

Some months ago this general boiler foreman was given the problem of building a firebox complete with crown, sides and combustion chamber from what is probably the largest single sheet ever used for the purpose. The layout was developed and the firebox successfully fabricated.

With the idea that details of the problem might be of interest to others who from time to time have similar problems to handle, and that an independent solution by the editor of the Questions and Answers Department might indicate a simpler method of layout than the one followed, he suggested that the development be worked out and published. The value of the material was such as to warrant making the subject a chapter in the series on plate development. The principles outlined in the explanation may be applied generally to locomotive firebox layout work. At a later date it is hoped that a descriptive article will be made available covering the actual fabrication of the firebox in question.

Other readers have submitted questions which also are of sufficient importance to treat as subject matter for the plate development series of articles.

The point in all this is that, when a problem presents itself for settlement in the process of building, repairing, inspecting or maintaining boilers and pressure vessels or any of the wide range of plate products, the services of this publication are available to all our readers in seeking the proper solution.

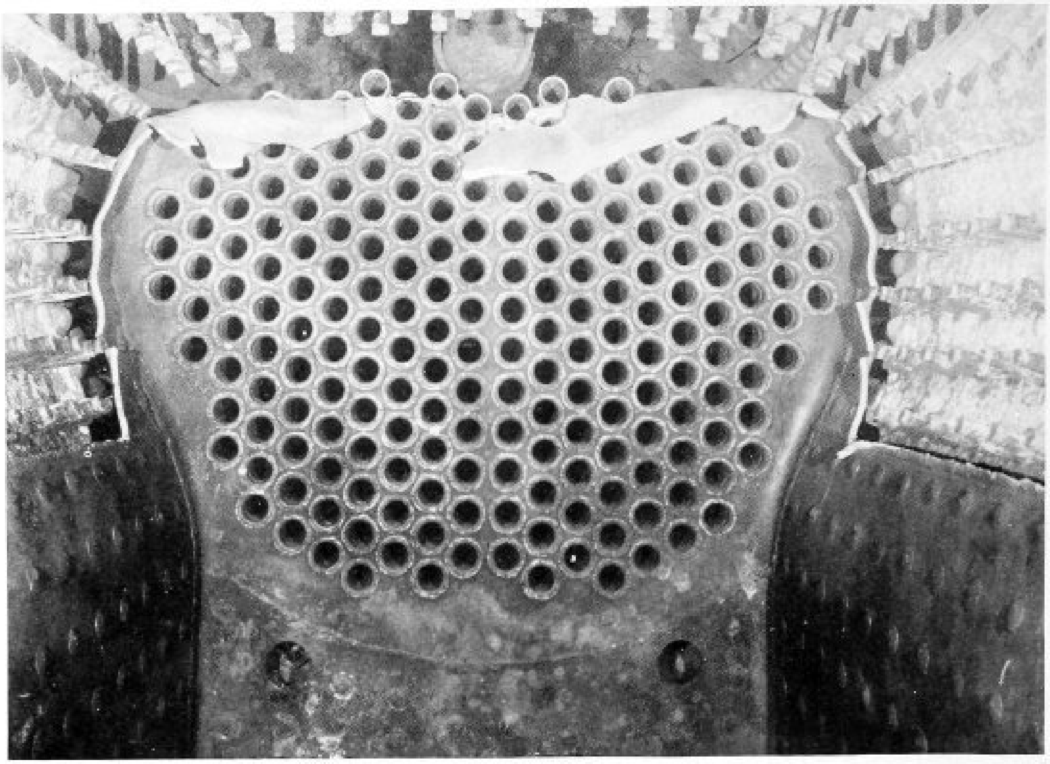

Fig. 1.—Disastrous crown sheet failure due to low water

Locomotive accidents outlined in

Bureau of Locomotive Inspection Report

The record of locomotive accidents which occurred during the fiscal year 1935, as compiled for the twenty-fourth annual report of the Bureau of Locomotive Inspection to the Interstate Commerce Commission by former Chief Inspector A. G. Pack,* is in part as follows:

Summaries are given, by railroads, of all accidents, showing the number of persons killed and injured due to the failure of parts and appurtenances of locomotives, as reported and investigated under section 8 of the locomotive inspection law, and those reported to the Bureau of Statistics under the Accident Report Act of May, 1910, and not reported to this bureau in accordance with the requirements.

The tables showing the number of accidents, the number of persons killed, and number injured have been arranged to permit comparison with previous years as far as consistent. These tables also show the number of locomotives inspected, the number and percentage of those inspected and found defective, the number for which written notices for repairs were issued in accordance with section 6 of the law, and the total defects found and reported. The data contained therein cover all defects on all parts and appurtenances of locomotives found and reported by our inspectors, arranged by railroads.

Summaries and tables show separately accidents and other data in connection with steam locomotives and tenders and their appurtenances and accidents and other data in connection with locomotives other than steam.

Boiler explosions caused by crown sheet failures continue to be the most prolific source of fatal accidents. There was an increase of 4 accidents, an increase of 17

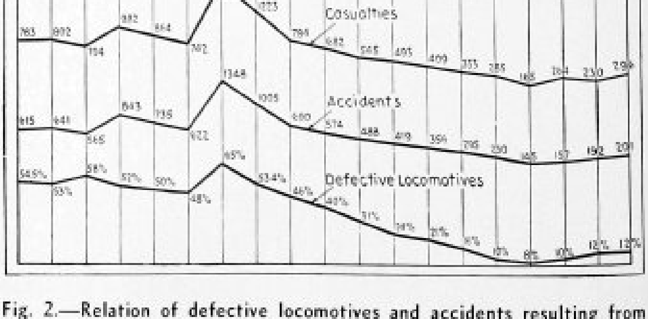

Fig. 2.—Relation of defective locomotives and accidents resulting from failures of some part or appurtenance

* A. G. Pack, chief inspector of the Bureau of Locomotive Inspection, did not retire until after the fiscal period, covered by this twenty-fourth annual report, to be succeeded by John M. Hall, present incumbent of that office.

in the number of persons killed, and an increase of 39 in the number of persons injured from this cause, as compared with the previous year.

One thousand four hundred and one applications were filed for extensions of time for removal of flues, as provided in rule 10. Our investigations disclosed that in 84 of these cases the condition of the locomotives was such that extensions could not properly be granted. One hundred and twenty-nine were in such condition that the full extensions requested could not be authorized, but extensions for shorter periods of time were allowed. One hundred and forty-one extensions were granted after defects disclosed by our investigations were required to be repaired. Twenty applications were canceled for various reasons. One thousand and twenty-seven applications were granted for the full periods requested.

Under rule 54 of the Rules and Instructions for Inspection and Testing of Steam Locomotives, 209 specification cards and 3185 alteration reports were filed, checked, and analyzed. These reports are necessary in order to determine whether or not the boilers represented were so constructed or repaired as to render safe and proper service and whether the stresses were within the allowed limits. Corrective measures were taken with respect to numerous discrepancies found.

Under rules 328 and 329 of the Rules and Instructions for Inspection and Testing of Locomotives Other Than Steam, 308 specifications and 29 alteration reports were filed for locomotive units and 92 specifications and 62 alteration reports were filed for boilers mounted on locomotives other than steam. These were checked and analyzed and corrective measures taken with respect to discrepancies found.

No formal appeal by any carrier was taken from the decisions of any inspector during the year.

In Fig. 1 is shown the interior of a firebox that failed,

Fig. 3.—This low water failure resulted in the death of one railroad employee

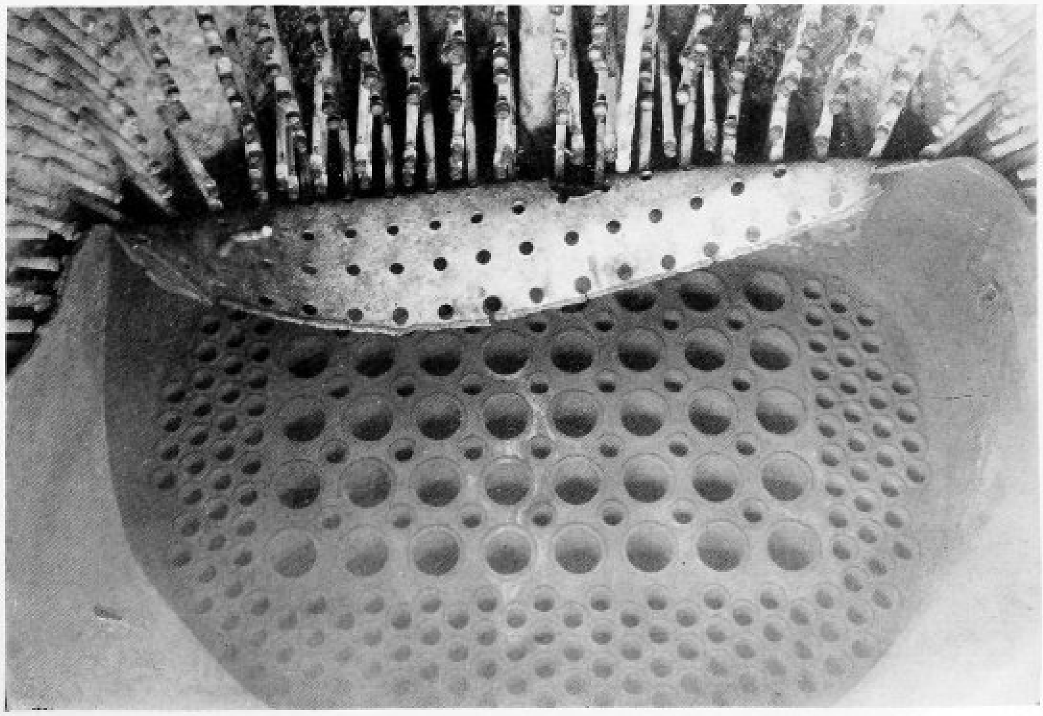

Fig. 4.—Interior of a firebox that failed by overheating of the crown sheet

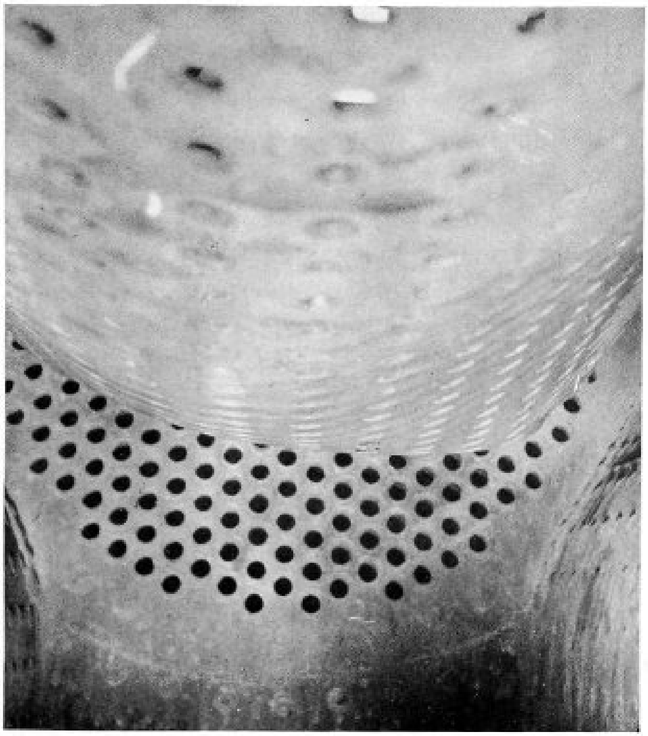

Fig. 5.—Another case of low water

ACCIDENTS AND CASUALTIES CAUSED BY FAILURE OF SOME PART OF THE STEAM LOCOMOTIVE, INCLUDING BOILER, OR TENDER

	1935	1934	1933	1932	1931	1930
Number of accidents	201	192	157	145	230	295
Percent increase or decrease from previous year	4.7*	22.3*	8.3*	36.9	22	17.1
Number of persons killed	29	7	8	9	16	13
Percent increase or decrease from previous year	314.3*	12.5	11.1	43.7	23*	31.6
Number of persons injured	267	223	256	156	269	320
Percent increase or decrease from previous year	19.7*	12.9	64.1*	42	15.9	17.9

* Increase.

ACCIDENTS AND CASUALTIES RESULTING FROM FAILURES OF BOILER PARTS AND APPURTENANCES

Boiler part or appurtenance which caused accident	1935			1934			1933			1932			1931		
	Accidents	Killed	Injured	Accidents	Killed	Injured	Accidents	Killed	Injured	Accidents	Killed	Injured	Accidents	Killed	Injured
Arch tubes	1	.	1	.	.	.	1	.	1	.	.	.	2	.	3
Ash-pan blowers	.	.	.	2	.	2	.	.	.	.	.	.	.	.	.
Blow-off cocks	6	.	6	5	.	5	8	.	8	.	.	.	5	.	5
Boiler checks	2	.	2	4	.	4	.	.	.	.	.	.	1	.	1
Boiler explosions:															
A. Shell explosions	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
B. Crown sheet; low water; no contributory causes found	6	17	52	6	4	18	5	2	6	5	5	6	10	7	32
C. Crown sheet; low water; contributory causes or defects found	5	4	8	1	.	3	.	.	.	1	3	3	3	8	8
D. Miscellaneous firebox failures	1	3	.	1	.	1	.	.	.	2	.	2	1	.	1
Dome caps	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.
Fire doors, levers, etc.	1	.	1	4	.	4	3	.	3	2	.	2	2	.	2
Flues	3	.	3	4	.	8	5	.	6	4	.	4	13	.	13
Flue pockets	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gage cocks	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Grate shakers	7	.	7	5	.	5	4	.	4	7	.	7	8	.	8
Handholds	7	.	7	7	.	7	6	.	6	4	.	4	6	.	6
Injectors and connections (not including injector steam pipes)	1	.	2	1	.	1	4	.	4	1	.	1	5	.	5
Injector steam pipes	6	.	6	3	.	3	1	.	1	1	.	1	1	.	1
Patch bolts	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plugs, arch tube and washout	1	.	2	.	.	.	2	.	3	.	.	.	.	.	.
Plugs in firebox sheets	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rivets	2	.	3	.	.	.	.	.	.	.	.	.	1	.	1
Safety valves	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Sanders	1	.	1	3	1	2	2	.	2	.	.	.	3	.	3
Staybolts	1	.	1	1	.	1	.	.	.	2	.	2	4	.	4
Studs	1	.	1	.	.	.	.	.	.	.	.	.	1	.	1
Superheater tubes	1	.	1	2	.	5	3	.	3	2	.	2	4	.	5
Water glasses	8	.	8	11	.	11	11	.	11	7	.	7	8	.	8
Water-glass fittings	.	.	.	1	.	1	.	.	.	.	.	.	2	.	2

ACCIDENTS AND CASUALTIES CAUSED BY FAILURE OF SOME PART OR APPURTENANCE OF THE STEAM LOCOMOTIVE BOILER*

	1935	1934	1933	1932	1931	1930	1915	1912
Number of accidents	68	63	53	43	91	105	424	856
Number of persons killed	24	4	3	8	15	12	13	91
Number of persons injured	119	77	55	46	122	113	467	1,005

* The original act applied only to the locomotive boiler.

NUMBER OF STEAM LOCOMOTIVES REPORTED, INSPECTED, FOUND DEFECTIVE, AND ORDERED FROM SERVICE

Parts defective, inoperative or missing, or in violation of rules	1935	1934	1933	1932	1931	1930
1. Air compressors	733	660	474	417	481	873
2. Arch tubes	74	127	51	54	60	87
3. Ash pans and mechanism	94	87	40	69	81	76
4. Axles	10	6	21	13	10	12
5. Blow-off cocks	283	289	210	144	191	325
6. Boiler checks	413	407	293	214	263	521
7. Boiler shell	396	372	296	220	430	579
8. Brake equipment	2,449	2,326	1,696	1,645	1,923	2,706
9. Cabs, cab windows, and curtains	1,273	1,342	1,183	851	1,484	3,066
10. Cab aprons and decks	368	343	309	262	415	710
11. Cab cards	142	129	121	162	211	226
12. Coupling and uncoupling devices	73	54	67	85	98	122
13. Crossheads, guides, pistons, and piston rods	1,086	1,100	773	763	856	1,421
14. Crown bolts	75	77	67	50	96	95
15. Cylinders, saddles, and steam chests	1,547	1,491	1,084	841	1,265	2,311
16. Cylinder cocks and rigging	627	654	374	376	411	848
17. Domes and dome caps	94	105	76	45	83	154
18. Draft gear	423	401	318	325	568	950
19. Draw gear	414	480	357	371	640	1,003
20. Driving boxes, shoes, wedges, pedestals, and braces	1,573	1,472	1,080	821	925	1,359
21. Firebox sheets	343	356	246	235	341	471
22. Flues	173	203	150	120	187	254
23. Frames, tail pieces, and braces, locomotive	1,006	951	669	611	740	1,271
24. Frames, tender	124	128	80	86	105	177
25. Gages and gage fittings, air	275	212	145	156	192	290
26. Gage and gage fittings, steam	320	289	258	214	324	553
27. Gage cocks	480	384	388	330	415	783
28. Grate shakers and fire doors	394	404	245	288	410	767
29. Handholds	464	377	363	382	562	865
30. Injectors, inoperative	39	33	20	31	55	103
31. Injectors and connections	2,035	1,909	1,357	1,168	1,815	3,275
32. Inspections and tests not made as required	8,344	8,173	6,358	3,801	4,862	7,456
33. Lateral motion	389	351	269	237	289	372
34. Lights, cab and classification	81	79	76	55	77	119
35. Lights, headlight	257	218	169	119	180	373
36. Lubricators and shields	191	215	157	119	176	312
37. Mud rings	241	247	232	166	318	445
38. Packing nuts	527	491	419	402	523	828
39. Packing, piston rod, and valve stem	906	833	592	444	706	1,429
40. Pilots and pilot beams	152	174	123	145	160	272
41. Plugs and studs	167	242	151	176	182	348
42. Reversing gear	414	390	254	202	299	579
43. Rods, main and side, crank pins, and collars	1,826	1,670	1,327	1,256	1,520	2,488
44. Safety valves	100	108	53	63	61	116
45. Sanders	779	697	376	289	314	804
46. Springs and spring rigging	2,765	2,854	2,122	1,851	2,161	3,311
47. Squirt hose	113	107	93	96	184	313
48. Staybolts	240	285	219	181	293	395
49. Staybolts, broken	512	455	368	552	938	1,098
50. Steam pipes	463	489	338	285	512	730
51. Steam valves	212	267	193	143	226	399
52. Steps	640	567	498	622	676	1,021
53. Tanks and tank valves	913	862	600	587	732	1,426
54. Telltale holes	102	93	90	108	151	183
55. Throttle and throttle rigging	733	639	448	434	574	1,175
56. Trucks, engine and trailing	811	898	664	648	714	1,141
57. Trucks, tender	1,120	918	747	766	1,059	1,531
58. Valve motion	799	784	640	520	497	827
59. Washout plugs	679	776	623	599	815	1,283
60. Train-control equipment	4	8	4	13	9	48
61. Water glasses, fittings, and shields	951	907	716	676	955	1,501
62. Wheels	697	734	580	603	750	1,025
63. Miscellaneous-signal appliances, badge plates, brakes (hand)	563	572	423	325	418	691
Total number of defects	44,491	43,271	32,733	27,832	36,968	60,292
Locomotives reported	51,283	54,283	56,971	59,110	60,841	61,947
Locomotives inspected	94,151	89,716	87,658	96,924	101,224	100,794
Locomotives defective	11,071	10,713	8,388	7,724	10,277	16,300
Percentage of inspected found defective	12	12	10	8	10	16
Locomotives ordered out of service	921	754	544	527	688	1,200

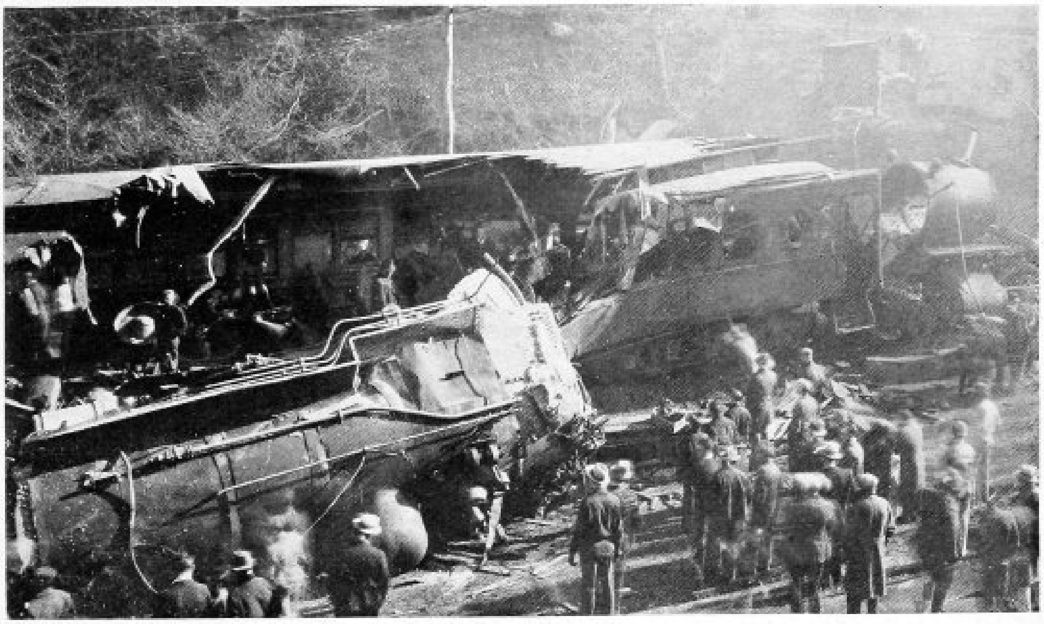

Fig. 6.—This disaster caused the death of sixteen persons and injuries to forty-three others

REPORTS AND INSPECTIONS—STEAM LOCOMOTIVES

	1935	1934	1933	1932	1931	1930
Number of locomotives for which reports were filed	51,283	54,283	56,971	59,110	60,841	61,947
Number inspected	94,151	89,716	87,658	96,924	101,224	100,794
Number found defective..	11,071	10,713	8,388	7,724	10,277	16,300
Percentage inspected found defective	12	12	10	8	10	16
Number ordered out of service	921	754	544	527	688	1,200
Total number of defects found	44,491	43,271	32,733	27,832	36,968	60,292

CONDITION OF LOCOMOTIVES, FOUND BY INSPECTION, IN RELATION TO ACCIDENTS AND CASUALTIES

Fiscal year ended June 30	Percent of locomotives inspected found defective	Number of locomotives ordered out of service	Number of accidents	Number of persons killed	Number of persons injured
1923	65	7,075	1,348	72	1,560
1924	53	5,764	1,005	66	1,157
1925	46	3,637	690	20	764
1926	40	3,281	574	22	660
1927	31	2,539	488	28	517
1928	24	1,725	419	30	463
1929	21	1,490	356	19	390
1930	16	1,200	295	13	320
1931	10	688	230	16	269
1932	8	527	145	9	156
1933	10	544	157	8	256
1934	12	754	192	7	223
1935	12	921	201	29	267

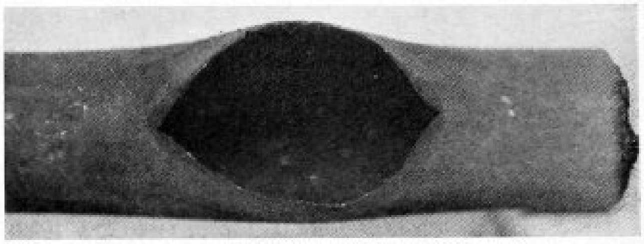

Fig. 7.—An arch tube that failed

Fig. 8.—Twist in a water glass steam pipe

caused by overheating of the crown sheet due to the impossibility of determining the true water level. This accident resulted in the serious injury of two employes. This accident occurred on the first trip of the locomotive after receiving repairs consisting of new half side sheets, three-fourths back flue sheet, new flues, and other work. The failed fusion welds in the side sheet seams were applied at this repair. The boiler was not properly cleaned at the time of and after resetting the flues. Oil in the boiler caused excessive foaming when the locomotive was running light on the break-in trip. The lowest reading of the water glass was 1½ inches higher than the lowest gage cock and the enginemen depended upon indications from the gage cock. Gage cocks entered the boiler direct, and tests on a similar locomotive showed that the gage cocks indicated a much higher water level than the actual water level in the boiler. Deterioration of the threads on the crown stays and the threads in stay holes in the crown sheet impaired the holding power of the stays.

The result of an explosion caused by overheating of the crown sheet due to low water while the locomotive was in charge of a watchman is shown in Fig. 3. This accident resulted in the death of the watchman. The force of the explosion tore the boiler from the frame and hurled it 150 feet forward and 33 feet to the right. Various parts that were broken off the boiler at the time of the accident were scattered over a radius of 300 feet.

The interior of a firebox that failed is illustrated in Fig. 4. The accident was caused by overheating of the crown sheet due to low water and resulted in the serious injury of four employes. Openings through the fittings of the water glasses were seriously restricted, the right tank valve was stopped up, and holes in the top of the tender at the rear of the fuel space allowed cinders and fine coal to enter the feed-water tank.

Another case of low water resulted in the serious injury of one employe. As shown in Fig. 5, the interior of the firebox failed, the crown sheet dropping several inches, pulling away from staybolts over a wide area.

The result of an explosion caused by overheating of the crown sheet due to low water is shown in Fig. 6. The locomotive was owned and operated by a coal mining company and was attached to a labor train on the mining company's property at the time of the accident. The explosion caused the death of 16 persons, the fatal injury of one person who died on the fourth day following the accident, and the serious injury of 43 other persons, all of whom were employes of the coal mining company.

In Fig. 7 is shown the result of an arch tube failure. One person was seriously injured. A twist in a water glass steam pipe, which was covered by lagging that concealed the twist, is shown in Fig. 8. The opening through the pipe was practically closed. The locomotive was withheld from service by the federal inspector for proper repairs.

The Maintenance Department

The cost of lost production time due to a breakdown and its repair should be added to the cost of the repair and the entire amount charged to the maintenance department—that is the belief of one of the executives quoted in *The Maintenance Department*, a report recently issued by the Policyholders Service Bureau, Metropolitan Life Insurance Company. Other equally suggestive comments, particularly concerning practices and procedures, are quoted in this new report, which is the result of a survey of the practices of several representative companies. Organization, operation and control methods are discussed in usable detail.

Preventive maintenance is listed as being one of the foremost of the various functions of maintenance departments. The report states that a popular procedure in carrying out a plan of preventive maintenance is the use of inspection report cards containing lists of items that must be checked. In a number of cases the inspector's report is in the form of a work order, having space for a description of the work to be done, estimate, actual cost, and essential information concerning start and completion of repairs. This form, and a number of others, are reproduced in facsimile in the report.

Under the heading "The Control of Maintenance Work," the report discusses budgets, order systems, schedules, authorization and wage incentive plans. The budgeting of maintenance work, states the report, is based upon these factors: Past experience, estimated increase in maintenance cost due to age of equipment, estimated reduction in maintenance cost due to preventive maintenance, and the forecast of volume of production for the next budget period. As in other parts of the report, the actual practices of representative manufacturers are cited in some detail.

"The education of maintenance employes to secure their co-operation in reducing costs," the report states, "will often assist in creating economies." Wage incentive plans, if practicable in individual plants, are cited as another method of producing economies. It is pointed out, also that should the maintenance department be charged as a matter of policy with the increased cost of production due to a breakdown, the department would establish rigid inspection methods and reduce penalties to a minimum. Readers desiring copies of this report may obtain them by addressing the Metropolitan.

Work of the Boiler Code Committee

The A. S. M. E. Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information on the application of the code is requested to communicate with the secretary of the committee, 29 West 39th St., New York.

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published.

Following are records of the interpretations of this committee formulated at the meeting of October 24, 1935, and approved by the council.

CASE No. 810—(*In the hands of the Committee*)

CASE No. 811—(*Interpretation of Pars. P-102i and U-68i*)

Inquiry: In connection with the X-ray examination of welds, the code specifies that the ratio of the distance between the focal spot and the outer side of the plate to the distance between the outer side of the plate and the film shall be not less than 7. Would it be acceptable to reduce this ratio to 5 when a grid of the Buckey type is employed to reduce scattering radiation?

Reply: Since recent reliable evidence indicates that in the case of X-ray films made with a grid of the Buckey type to reduce scattering radiation, a reduction of this ratio mentioned from 7 to 5 is, on the whole, more satisfactory, it is the opinion of the committee that in such cases the ratio of 5 will be acceptable.

CASE No. 812—(*Interpretations of Par. P-299*)

Inquiry: What is the limiting boiler pressure for cast-iron water columns under the requirements of Pars. P-321 and P-299?

Reply: It is the opinion of the committee that water columns made of cast iron equal to Specification S-13 may be used for maximum boiler pressures not exceeding 250 pounds per square inch.

Protecting Boiler Tubes from High Heat

There are various ways to enable boiler and superheater tubes to withstand higher temperatures. One is the use of tubes made of special alloy steel, usually containing some chromium, which is heat resistant and has less creep than the ordinary steels. Such special tubes will withstand higher temperatures with less loss of strength and tendency to blister. Another is coating the outside of fire tubes with aluminum (calorizing). This thin coating appears to give some protection of the metal against high furnace temperature. It has been used on tubes of Mercury boilers and is employed sometimes on superheater and fire row tubes. The most obvious thing, however, is to maintain the water or steam surface clean and absolutely clear of all deposits. This is secured by having a smooth interior surface and by suitable chemical treatment of the boiler water.

Interpreting the A.S.M.E. Boiler Code*

Power Boilers and Pressure Vessels

***By Dr. D. S. Jacobus*†**

Directly after the formulation of the first Boiler Code and its presentation to the Council of the American Society of Mechanical Engineers, the Boiler Code Committee suggested to the council that it meet from time to time to interpret any features of the code on which questions might be asked and to suggest means of handling new constructions. The committee did not appreciate the immense amount of work that this would lead to, as since that time the Boiler Code Committee has met nine or ten times a year for this service and at present the Executive Committee of the Boiler Code Committee meets about the same number of times. A number of the subcommittees of the Boiler Code Committee and special committees also hold meetings. In all of this work the conference committee of the Boiler Code Committee which is made up of representatives appointed by the various states and municipalities that have adopted the Code, have co-operated actively with the Boiler Code Committee and rendered most useful service.

One of the first difficulties met with in handling the interpretations was an effort made on the part of some manufacturers to secure the approval of the Boiler Code Committee to specific constructions with the idea of securing the hall-mark of the A. S. M. E. through the Boiler Code Committee. This led to the committee deciding to limit this service in so far as practicable to the interpretation of its published rules, and in dealing with new constructions to make suggestions that would be as general as possible and available to all.

The conference committee of the Boiler Code Committee which is made up of members of the National Board of Boiler and Pressure Vessel Inspectors has rendered most valuable assistance in connection with this work and it is only through the full co-operation of the conference committee with the Boiler Code Committee that it has been possible to conduct the work in such a way as to meet the needs of those enforcing the code.

Complaints have been received from time to time relating to the large number of revisions and interpretations, many of which were undoubtedly justified, which led the Boiler Code Committee to limit the volume of interpretations and revisions in so far as practicable. It does seem inevitable, however, that there must be a considerable number of revisions necessary if the desirable and orderly progress and improvement is not to be interfered with. The Boiler Code Committee should not be in the position of holding back improvement in pressure vessel construction. You may be sure, however, that the members of the committee do appreciate the necessity for restricting changes in the code to the greatest possible degree.

The inclusion of rules for fusion welding of drums and shells of power boilers which were prepared jointly by the Boiler Code Committee and the American Welding Society has led to a radical change in the construction of boilers and greatly increased the number of requests for interpretations. These rules were adopted by the Council of the American Society of Mechanical Engineers on July 7, 1931, and since that time the practice has changed so rapidly that the drums of nearly all high-pressure and high-duty steam boilers for central power plant service now constructed are fusion welded. The revision of the Unfired Pressure Vessel Code to include more general rules for fusion welding, which was made shortly after formulating the rules for fusion welding shells and drums of steam boilers, has also led to nearly all unfired pressure vessels being now constructed by fusion welding.

Few appreciate the magnitude of the welding industry and know of its rapid growth. This has naturally brought a number of questions before the Boiler Code Committee bearing on fusion welding and made it necessary to issue a number of interpretations. The welding rules are still incomplete and in the case of the Power Boiler Code they cover only drums or shells and certain specific constructions sanctioned by the code. The rules should be made as inclusive as is warranted by progress in the welding art and that they should be broadened where there is sufficient evidence to show that this can be done with safety. The American Welding Society has co-operated in all important interpretations bearing on welding. We still do not know everything about fusion welding. The question of what vessels should be stress relieved after welding is one on which the Boiler Code Committee is giving careful consideration to all of the evidence that is being put before it. Again, many materials, such as alloy steels, are being welded whereas there are no rules to cover the greater part of such welding. We should all work together to perfect the rules and to make them more complete and inclusive. It is hoped that all of the National Board members will co-operate in pointing out to the Boiler Code Committee where interpretations or revisions will be necessary to keep the rules up to date.

Many of the interpretations and revisions are made as the result of inquiries and suggestions received from the state inspectors. Others are made through inquiries received from insurance companies, manufacturers and users. The widely diversified sources of these inquiries and suggestions shows the general interest taken in the code and also shows that the strength of the committee comes through co-operation and the willingness of its friends to lend a helping hand.

We have worked together ever since the first code was issued in 1914 and up to date all final actions have been unanimous. This is a unique record for a committee of so large a size for a term of service of over 20 years, in which there have been about 200 regular meetings. Our strength for the future lies in continuing our co-operation as in the past and freely discussing all matters which come before us with the idea of continuing unanimity of action. Let us look forward to happy days in the future and make every effort to continue what has been a most pleasing and harmonious co-operation.

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* Address at tenth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors.

† Advisory engineer, Babcock & Wilcox Company, New York.

Inspecting and maintaining oil

REFINERY PRESSURE VESSELS*

***By F. L. Newcomb*†**

Pressure vessels containing petroleum products and gases seldom operate as isolated pieces of equipment. They are usually part of a complex group of equipment consisting of several different types of vessels, including heat exchangers, interconnected with piping and frequently operating in connection with a furnace, or other means of heating the oil. In addition, several different pressures may prevail in various parts of the equipment and different vessels, constituting part of the same equipment, may be designed for and operate under different pressures. The various pressures in different parts of the equipment may be maintained by automatic devices or by hand-throttling. Temperatures also vary considerably throughout a unit and may be controlled either manually or automatically. Both temperature and pressure may be varied from time to time depending on the stock being processed or the products being made. Some equipment is suitable for a number of different operating processes and operating conditions may vary widely. It is essential to know the conditions which will be encountered when inspecting and approving equipment for use and unless it is suitable for the most severe methods of operation, it is necessary to limit the operations which may be performed.

Conditions Affecting Inspection

Owing to the interconnection of a number of vessels in one system by piping and dependence on valves for controlling pressure at the various points, it is not feasible to divorce the inspection of the vessels from the other parts of the equipment. Failure of piping may discharge the entire contents of a vessel, or an entire system, onto the ground. The contents being flammable and frequently at high temperature, may result in a fire or explosion and the property damage and hazard to the personnel may be as great as though a vessel failed. Piping being of thinner wall than a pressure vessel usually has less corrosion allowance and in addition is subject to strains due to expansion or contraction, vibration, etc. It, therefore, follows that, to prevent accidents, not only the pressure vessels, but the entire unit must be subjected to the same careful inspection. It also follows that some parts of the equipment may need much more frequent inspection than others.

Valve failures may cause the contents of a vessel under high pressure to discharge rapidly into another vessel designed for much lower pressure. Therefore, safety relieving devices must be adequate for emergency conditions and must be in first-class operating conditions at all times. The relieving capacity of a safety valve is dependent not only on the pressure under the valve, but on the molecular weight and temperature of the vapor being discharged. This is taken into consideration in working up tables of relieving capacities for steam safety valves. Owing to the many different kinds of vapor encountered in oil refinery equipment, and the many different combinations of pressure and temperature involved, it is impossible to work up tables of relieving capacities for oil safety valves. The adequacy of the safety valves can only be determined for each case by calculation which requires a knowledge of the stocks being processed and the pressure and temperature used.

Research and experimental work frequently leads to changes in operating procedure involving combinations of conditions not anticipated at the time of design or inspection. It then becomes necessary for the inspection organization to re-compute the equipment for the changed conditions and advise as to its suitability and what, if any, changes are required, so that it may be operated safely. Also, as deterioration occurs, operating conditions can often be modified, even though some reduction in efficiency of operation may result, so as to bring them within the safe limitations of the vessel and thus avoid immediate replacement of equipment.

All types of corrosion are involved. In some cases, it is plainly apparent that corrosion is occurring as evidenced by pitting, grooving and the like. Much more frequently, however, the effects of corrosion are not so readily apparent. Frequently the corroded surface is as smooth as the original surface. In riveted construction the metal in the vessel corrodes in such a manner that there still appears to be a full rivet head. Only by careful examination, to find the line between the rivet head and the vessel wall, can one determine that the rivet head is seriously corroded. In modern welded vessels fillet welds and the vessel wall will also corrode at the same rate giving a false impression of a good bead of welding when in fact, practically none may remain. Cast iron parts, where used, are frequently subject to graphitization. This is a leeching out of the iron content, leaving the graphitic content intact. The wall of the casting will remain its original thickness, unless there is erosion, and the appearance of the material will not change other than to appear slightly darker. This graphitic material has practically no strength and may constitute a serious weakness in cast-iron or semi-steel shells of exchangers and similar equipment, unless detected and its depth determined.

Wide Variation in Rate of Corrosion

Corrosion rates vary considerably from time to time. Many refineries receive their crude from several different sources and the corrosive properties of these crudes may be widely different. Thus a certain piece of equipment may handle several different charging stocks of varying corrosive properties over a period of time. In addition, operating conditions on a given piece of equipment may be varied to produce products of various specifications and this also affects the corrosion rate. It, therefore, becomes extremely difficult to determine corrosion rates unless in close contact with operations so that one has a good knowledge of the conditions prevailing.

* Abstract of paper presented at the tenth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors. This is the second instalment; the first appeared on page 340 of the December 1935 issue.

† Supervising engineer, Safety Inspection Division, General Engineering Department, Standard Oil Development Company, Elizabeth, N. J.

The insides of petroleum pressure vessels are frequently coated with various substances such as tar, coke and the like. The metal surface is almost always badly discolored. These conditions make the detection of defects difficult. It is often necessary to wire brush the surfaces and at times it is necessary to clean them by means of sandblasting, using a fine sand so as not to mar the surface of the metal and still further conceal the defects.

A great many petroleum pressure vessels contain a considerable amount of internal equipment, such as a series of bell cap trays, to cause the rising vapors to bubble through a descending liquid; pans to catch the descending liquid and condensate; pipe coils, used for absorbing heat from the vapors into the feed stock and causing certain fractions of the vapor to be condensed; and internal bracing. All of these add to the difficulty of making inspections and sometimes require the development of special methods of inspection and special instruments for measuring thickness.

Vessels operating under temperature and those operated at sub-zero temperatures are insulated, generally using an expensive material such as cork or the better grades of asbestos insulation. Removal of this insulation causes large losses of material and is extremely expensive. For this reason complete external inspection of such vessels is usually only performed when internal or other indications appear to justify it. However, many vessels have removable sections of insulation over the joints so they may be more readily inspected.

Method Employed in Making Inspections

General.—No positive statement can be made as to where corrosion or other deterioration will not be found. On the other hand, experience has provided many guiding principles by which it can be stated with a fair degree of certainty where trouble is most likely to be experienced. There is a great difference between these two statements and the attitude of the inspector must always be that he may find corrosion anywhere until he has assured himself that there is none. Whenever any change is made in the operation of a piece of equipment, whether it is a change in pressure, temperature, character of the contents, substitution of a corrosion-resistant material for one which formerly was badly attacked, or any other change, the inspector must again take the attitude that corrosion may be found at any point where previously it had not been experienced. The more inquisitive the inspector, the better will be the results of the inspection.

Some of the points where most serious corrosion is to be expected are as follows:

In vessels containing corrosive liquids the most serious corrosion is frequently at the liquid level. However, sufficient investigation of the remainder of the equipment must be made to determine that this is the case.

In vessels through which vapor or gases flow, the most serious corrosion is frequently experienced in the vicinity of the inlet.

In piping through which fluids are flowing, it is generally safe to assume that the higher the velocity, the greater will be the corrosion. Also, at points where turbulence occurs, the corrosion will probably exceed that found at other points.

Gate valves frequently are found to be seriously affected in the body between the seats and particularly if they are used for throttling purposes.

Visual Inspection.—Where the size of the vessel and internal arrangement is such as to permit, the inspector enters the vessel and gives it a thorough visual inspection. During this examination careful note is made of any pitting, grooving, cracking, checking, scaling, bulging or other irregularities, or doubtful conditions. Points where defects or doubtful conditions are found are further investigated by other methods to determine the amount of sound metal remaining.

Where the size of the vessel will not permit entry, the interior is given as thorough a visual inspection as possible through all openings and any unusual conditions noted and investigated.

In the case of lined vessels, particular care is taken to see that the lining is in good condition and is protecting the metal beneath it.

During the internal inspection, all interior equipment is carefully examined. Particular attention is given to the supports of pipe coils, trays, pans and so forth to see that they are adequate to carry the load. In riveted vessels the heads of all rivets are examined for corrosion, undercutting or other deterioration, since their condition gives a quick and reliable indication of the location of the most severe corrosion. The condition of all attached piping, nozzles, manheads and so forth are observed from the interior of the vessel.

The exteriors of vessels are carefully examined for signs of leakage and, if uninsulated, any unusual conditions are noted. All attachments to the vessel are observed and particular attention is given the supporting members to see that they are in condition to carry the load.

Sounding.—Sounding with a hammer to determine thin areas, loose rivets, etc., is employed when this is applicable.

Thickness Determinations.—Several different methods are employed for determining the remaining metal thickness after corrosion, depending on the thickness of the vessel and its position. For determining the thickness of a vessel from $\frac{3}{16}$ inch to 2 or $2\frac{1}{2}$ inches thick, it is usually feasible to drill small holes at the point one desires to investigate and later tap these holes with a pipe or taper tap and plug them so they can be used during future inspections. In some cases these holes are permanently plugged, frequently by welding and new holes drilled at each inspection. When the thickness of metal in a vessel is definitely known and it is not desirable or feasible to drill holes for determining future thicknesses, the depth of corrosion may be determined by establishing protected surfaces at predetermined points on the inside of the vessel. This can be done by welding on corrosion-resistant strips or buttons and later removing this protection and measuring the depth of corrosion from the protected surface under them. Another method is to drill small holes on the inside of the vessel at suitable places to a predetermined depth. Plugging these holes with a protective material prevents corrosion at the bottom. Loss in depth of the holes represents the loss in metal thickness by corrosion. When it is necessary to determine the wall thickness of vessels and it is not feasible or desirable to drill completely through the wall, two taut parallel wires, one inside and one outside the drum are used. The metal thickness is obtained by measuring the distance from each wire to the corresponding adjacent surface of the vessel wall and deducting the sum of these readings from the distance between the wires. In some cases wall thickness may be estimated by measuring the inside diameter with inside micrometer calipers. In such case, the wall thickness must be figured as one-half the difference between the inside and outside diameters. Since most of the corrosion found in petroleum vessels is not uniform, this method may result in considerable error and should not be used if the thickness can be determined by any other method and then should be used only with discretion.

Pressure Tests.—New vessels or those which have undergone extensive repairs are given a pressure test as recommended by the API-ASME Code. During regular periodic inspection or after ordinary repairs, pressure tests are not always given, since some water may remain trapped and cause sudden excessive pressures when hot oil enters the vessel. When the pressure test has not been made, a steam or inert gas pressure test, somewhat lower than the normal operating pressure, is generally applied and the vessel and all of its connections are carefully observed for signs of leaks. This is done to assure that no openings have been left in the vessel and that all manhead covers, handhole covers, pipe connections, etc., have been tightened.

Care of Instruments and Gages.—The proper operation of equipment and, to a large extent, the safety of the equipment is dependent on the condition and accuracy of the various instruments and gages. Since the adjustment and repair of the many modern recording and controlling instruments is a highly specialized field, the inspector is not expected to be familiar with these details. However, it is his duty to see that all instruments and gages are checked periodically to assure that they are accurate and in good mechanical condition at all times and in addition to ascertain that any connecting piping or wiring is in good condition, properly connected and adequately protected against damage.

Maintenance and Testing of Safety Valves.—Owing to corrosion and the possibility of deposited coke, tar, wax or the like causing sticking, all safety valves suitable for steam are not suitable for oil and its vapors. It is the inspector's duty to see that safety valves suitable for the conditions are installed and that they are removed, tested, cleaned and reset as often as necessary to keep them relieving at their set pressure. The care and maintenance of safety valves on oil refinery equipment is a far different problem than that encountered in steam, air or other clean service.

An Inspector's Tools.—An oil refinery inspector's kit of tools must be sufficiently extensive to make all necessary measurements and determine the exact condition of the equipment. As an example, each of our own inspectors is equipped with the following:

1. A good ball pean machinist's hammer.
2. Outside spring calipers, 6-inch size.
3. Inside spring calipers, 12-inch size.
4. Outside lock joint transfer calipers, 12-inch size.
5. A 6-inch scale (graduated in 64ths and 32nds).
6. A depth gage.
7. A good magnifying glass.
8. A focusing flashlight.
9. A small pocket mirror.
10. Special inspector's gages.
11. A pair of indicating calipers with detachable legs and special sets of legs to reach and measure otherwise inaccessible places.
12. A small scraping tool for insertion through test holes to remove burrs, insulation and deposits.
13. A feeler and scraper made from a broken hacksaw blade.
14. An aluminum sheet holder, size 8½ by 11 inches for holding and protecting inspection forms and notes.

Records.—The records required for refinery inspections are many and varied. A large number of different forms are required for recording field data in order to expedite the work of the inspector, thus avoiding lost time on equipment, and to make it convenient for later checking and future use. In many cases a part of the field data must be transferred to other forms so as to keep a running record of the condition of the equipment, from which the progress of corrosion can readily be obtained. It is essential to have all records quickly available to determine whether equipment is suitable for desired changes in operating conditions.

Briefly, careful systematic inspection of refinery equipment has resulted in safer equipment, safer working conditions, fewer accidents, more reliable and continuous operation and monetary savings. Thorough, systematic inspection is not considered by the oil industry as "just another expense" but as a necessity.

Flaxseed in Marine Boilers

Flaxseed meal has been used for considerable periods for the purpose of stopping leaks in water containers and low-pressure boilers that have become corroded. This meal, which is made by crushing the seed, swells up as oatmeal does when soaked in warm water. It will then flow to the point of leakage and build up there and thus stop the leak. This, however, is effective only for very low pressure and is not a permanent leak stop. It is not believed that this has been used to any great extent on ships.

An extract of flaxseed is used in an apparatus called the filtrator and it has been used extensively for boiler water treatment to prevent scale. In this case, the flaxseed is put in an iron pot and low-pressure steam is blown through it. This heating by means of the steam loosens an extract from the husks of the flaxseed which has certain colloidal attributes; while it does tend to prevent scale from forming, it is not a proper feed-water treatment.

The rancid odor given off by flaxseed is caused by vegetable decomposition and it is understood that this is difficult to prevent. However, by treating the flaxseed or flaxseed meal with some chemicals which would tend to retard the formation of bacteria, this action might be retarded.

It is believed that there are many things which can be used for stopping leaks in low-pressure systems, such as treated sawdust, which would not have the objectionable odor.

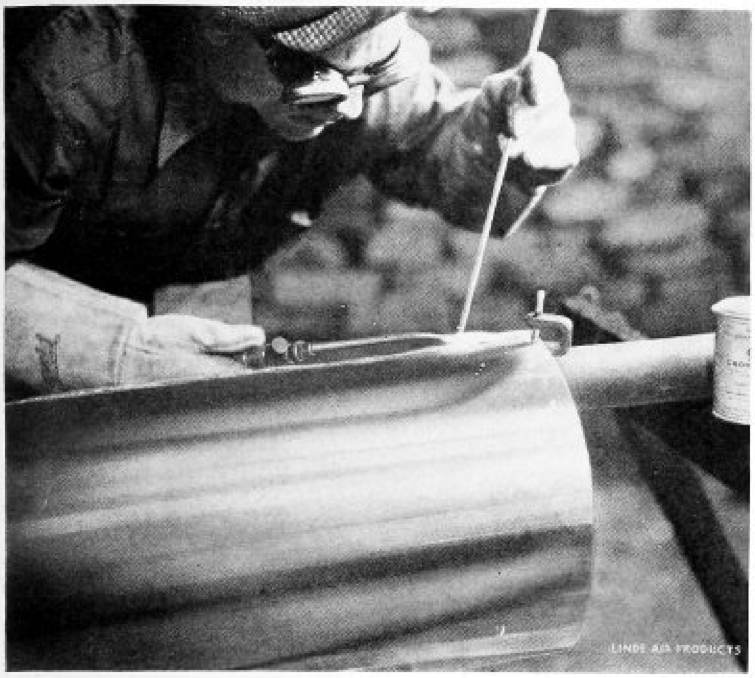
Revised New York State Boiler Code

At the request of William H. Furman, chief boiler inspector, Bureau of Boiler Inspection, State of New York, the following notice is brought to the attention of readers, building, installing, inspecting or operating boilers in the State of New York:

The New York State Department of Labor desires to call attention to the fact that the revised New York State Boiler Code is now ready for distribution.

There have been numerous changes made in the code. Those installing boilers should particularly note the revisions made in Rule 14-2.17, also Pars. P-9, 12, 24, 25, 101 to 111 inclusive, and Pars. P-268 to P-328 inclusive.

In accordance with the requirements of Chapter 220, Laws of 1933, a charge must be made for all publications. A charge of one dollar has been placed upon the Boiler Code, which is known as Bulletin No. 14. A copy of the code may be secured by addressing the Bureau of Publications at the New York Office, 80 Centre Street, or at the Albany office, Room 905, State Office Building. Stamps will not be accepted.



Welding a stainless steel container

Oxygen and acetylene for

Welding and Cutting*

By E. V. David†

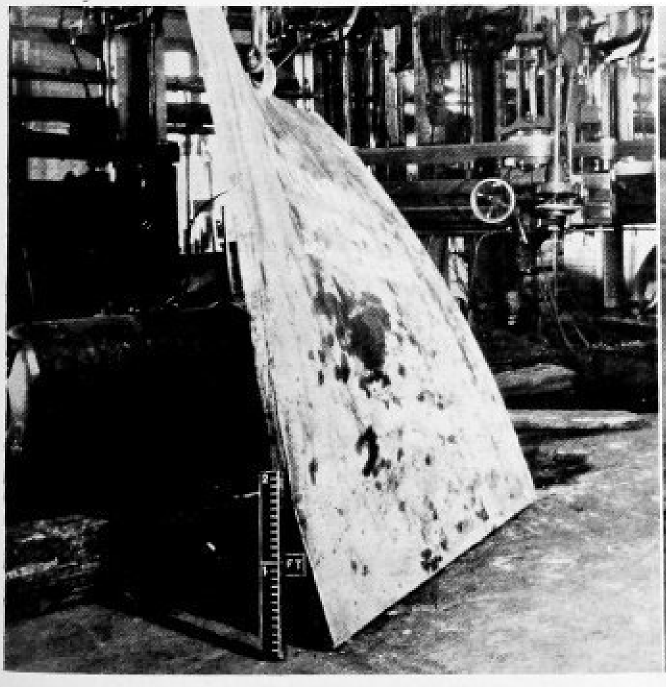
Fifteen years ago the oxy-acetylene torch still was considered by many as somewhat of a novelty. Ten years ago its utility as an important repair and reclamation device was conceded generally. Five years ago it already was widely accepted as a major production tool. Today manufacturers have literally been forced to turn to welding and cutting in many lines where these processes have rendered older methods entirely obsolete.

Progress in oxy-acetylene welding and cutting in the United States during the past year has been marked by many notable introductions of new applications, methods and apparatus. Startling and even revolutionary recent discoveries have been eagerly investigated and adopted by industry wherever possible, resulting in new economies in operation, production and maintenance.

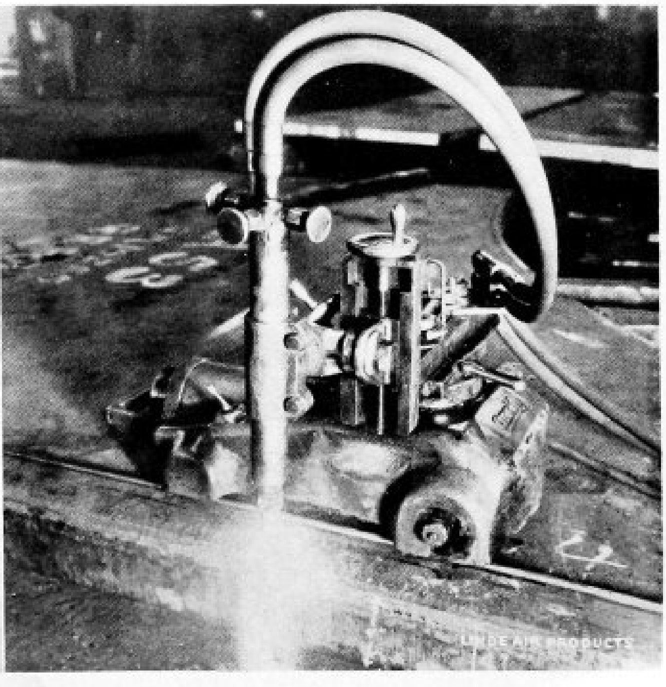
One of the principal factors working to increase greatly the use of welding and cutting in recent years has been the widespread modernization of American products. Welding and cutting, in turn, are the processes which have made this possible. American business men have discovered that the most effective way to get sales today is to make a product that by its very appeal and attractiveness will practically sell itself.

*Abstract of paper presented at the 36th Annual Convention, International Acetylene Association.

† General chairman, Oxy-Acetylene Committee, International Acetylene Association, New York.



Flame-cut penstock plate for Boulder Dam



Portable oxy-acetylene cutting machine

Welded seams and cut edges are smooth enough for many purposes without further finishing, but can be ground smooth and made invisible where necessary. Furthermore, welding and cutting meet all three dimensions of industrial design—appearance, cost and durability.

The oxy-acetylene process is largely responsible for lighter weight machines and products. Greater strength is obtained even where sections used are thinner. Altogether, welding and cutting have proved lifesavers to industry in this fast-changing era.

Another notable development in recent years, from the standpoint of the fabricator, is that of the so-called low alloy high-tensile steels, with yield points and ultimate strengths nearly double those of low carbon steel. Wise executives are watching their progress with avid interest. Much more will be heard of them as time goes on. Entirely new fields are opening because of these steels. The possibilities of welded constructions incorporating them have just begun to be realized.

Undoubtedly the largest single application of low alloy high-tensile steel thus far was in the penstocks for Boulder Dam. These penstocks ranged from 13 feet to 30 feet in diameter. Over 45,000 tons of rolled steel plates, ranging in thickness from ⅝ inch to 4½ inches were required for their construction. These plates were prepared for welding by oxy-acetylene machine cutting. In many cases, the cutting was done after the plates were formed into irregular curved shapes to be welded without further finishing.

Further research has been conducted on the metallurgy of oxy-acetylene welding of steel and interesting and valuable reports rendered. Additional proof has been submitted that the quality of a weld—its strength, ductility, grain structure, machinability, surface finish—is dependent in a large measure upon the quality of the welding rod used. Normalizing and stress-relief also were investigated further during 1935.

Welding and metallurgical engineers have co-operated in developing suitable welding techniques for new metals and alloys produced. Makers now recognize that welding is one of the methods most widely accepted by the fabrication industries and that weldability is one factor which cannot be overlooked. Similarly, co-operation between the users and the oxy-acetylene industry has resulted in development of suitable oxy-acetylene cutting techniques for many of the newer alloy steels.

A survey of present-day torches or blowpipes will show that they are becoming steadily more compact, lighter, better balanced, more skillfully proportioned and more precisely machined. There is a decided tendency to make them more adaptable to various types of work, thus giving them greater all-around utility. They are several torches in one, as it were. The tendency to provide torches which will permit greater production per man hour continues.

Regulators of two-stage type have retained their deserved popularity. They give much more accurate regulation of the pressure and volume of gases used in all oxy-acetylene operations. This, of course, is of the utmost importance, as it is directly responsible for the better quality of work obtained. Considerable developments have occurred recently in acetylene generators of all capacities and types.

Obviously, in reviewing recent progress in oxy-acetylene welding, with its present-day almost endless ramifications, it will not be possible to do more than touch briefly on some of the representative highlights and thus endeavor to secure a bird's-eye view of the developments and trends.

Oxy-acetylene welding of pipe is now so generally accepted that it hardly appears to require special mention here. This process insures strong, leak-proof, permanent joints and the excellent past performance of welded pipe has made an extremely favorable impression on industry generally.

Bronze-welding of ferrous metals is another oxy-acetylene application which has continued to forge to the forefront. For heavy maintenance and repair work particularly, bronze-welding, in many cases, has turned the spectacular into the routine. An interesting recent case of bronze-welding in construction was that of a steam anvil hammer 13,000 pounds in weight which was fabricated by a midwestern railroad shop. The cast iron bottom and steel top of the hammer were bronze-welded together. The weld was completed in 14 hours and 935 pounds of bronze rod were required.

Oxy-acetylene welding of the stainless steels has shown considerable progress. Satisfactory techniques now have been developed for welding nearly all of these materials. Wherever possible the manufacturer's detailed instructions should be obtained before welding is started, however, and the proper procedure as indicated carefully followed. A recent outstanding example in this field which comes to mind, is that of an oxy-acetylene welded stainless steel-lined barrel for fruit now being made by a Pacific Coast manufacturer. This barrel is of a new type with full-removable head. The polished flat stainless steel sheet used is formed into a cylinder and the longitudinal joint oxy-acetylene welded in a jig. This cylinder is then inserted into the outside steel cylinder to form the liner and the ends of both cylinders curled over. Finally, both cylinders are expanded together to form the rings on the completed barrel. The welded seam withstands this severe punishment, which incidentally is a fine example of the workability of the stainless steel as well, without failure.

In considering welding in its various aspects, we are at times apt to overlook our even more important companion process, oxy-acetylene cutting. The simplest device for cutting is, of course, the oxygen lance which continues to find increased uses for tapping furnaces, cutting salamanders and similar applications. The hand cutting torch, of course, continues to be one of the most widely used tools in the metal working industries. Profound changes have been wrought by its introduction.

One recent spectacular example of hand cutting was the demolition of the west tower of the Century of Progress world-famous Sky Ride which rose to a height of 628 feet. This towering mass of structural steel was wrecked June 8, 1935. Final cuts were made by eight experienced torch operators, previously rehearsed, who completed the notches in the eight cable anchorage plates. The uncut portions of the plates were then dynamited and the tower crashed—almost exactly along the line predetermined.

Turning now to machine gas cutting, we find changes continuing to take place that give promise of greatly extending the usefulness and economy of this extremely versatile process. This "metal carpentry" or "tailoring" as some choose to call it, is laden with possibilities for improving design, speeding up production and effecting major economies in the making of steel parts of every description, and in the modern practice of welded fabrication where it acts as a companion process to welding.

Machine gas cuts are accurate and can be made to close tolerances. They have sharp corners and edges and compare favorably with a roughing cut made by a planer or shaper. They are good enough to be used without extra machining on any job that would not ordinarily call for a machine finish. Machine gas cut parts virtually fall into place in an assembly.

Developments in oxy-acetylene flame cutting machines have kept pace with the increase in the use of the process. These machines make parts in a fraction of the time that would be required to produce them by other methods and at a fraction of the cost.

Particularly in recent times, one of the principal uses of the cutting torch has been for scrapping. Obsolete steel equipment and structures of all types also are scrapped or demolished with cutting torches to standard charging box size and the materials classified and sold at a profit. The very extensive car and locomotive scrapping programs of the railroads carried out during the past few years have furnished a good example of this. Oxy-acetylene cutting has put steel scrapping on a profitable basis.

The formulation and adoption of suitable codes and specifications for oxy-acetylene welding and cutting in various fields have proved most advantageous in securing general recognition and acceptance of these processes. During the past year, substantial headway in this respect has been achieved. The more important codes and rules issued recently were:

1. American Welding Society tentative recommendations describing procedure to be followed in preparing for welding and cutting certain types of containers which have held combustibles.
2. American Welding Society marine code for welding and gas cutting—Part D.
3. Code for fusion welding and gas cutting in building construction—Part 8—Structural Steel, edition of 1934.
4. A tentative code for fusion welding and flame cutting in machinery construction.
5. Code for pressure piping, sponsored by the American Society of Mechanical Engineers and approved by American Standards Association. Section 5 starting on Page 3, covers welding pipe joints.
6. Rules for the fusion welding of gravity tanks, tank risers and towers were prepared by a joint committee of the American Welding Society and the International Acetylene Association at the instance of the National Board of Fire Underwriters' Engineering Council. Undoubtedly, these rules are of the greatest importance to the welding industry, to heating and piping contractors and to those designing or owning buildings.
7. The International Acetylene Association issued two pamphlets entitled "Tests for the Selection of Operators of Welding Equipment" and "Model Purchase Specifications for Welding Piping" which come under this category. These were prepared by the Oxy-Acetylene Committee.
8. The Boiler Code Committee of the American Society of Mechanical Engineers proposed changes in the A.S.M.E. Boiler Code providing further use of oxy-acetylene flame cutting for the preparation of steel plate edges in steel of up to 0.35 carbon content for boiler and pressure vessel fabrication work. This is one of the most significant recognitions that the oxy-acetylene process has received recently.

Last year, the directors of the International Acetylene Association approved the issuing of separate pamphlets covering the various important phases of the oxy-acetylene process. These replaced the single general booklet containing the Oxy-Acetylene Committee report compiled annually up to that time. Four pamphlets were published last year. They have proved of considerable value as text or reference books.

This year, the work of the Oxy-Acetylene Committee has continued to be directed along similar lines. Four additional pamphlets on pertinent technical subjects have been prepared and publication authorized by the directors.

The pamphlets are entitled "Tests for the Selection of Operators of Welding Equipment"; "Model Purchase Specifications for Welding Piping"; "Bronze Welding or Hard-Brazing of Cast Iron and Malleable Iron by the Oxy-Acetylene Process" and "The Effect of Flame Cutting on Steel".

Replacing Defective Tube in A-Type Boiler

What is the procedure to follow for replacing a single defective tube located approximately in the center of the tube bank of express or type boilers such as Yarrow or White-Forster? This is a question asked by some of our marine readers. The following explanation may help in solving the difficulty:

If there is only one defective tube, the most logical procedure would be to fit plugs in each end of the tube and allow it to burn out. One tube more or less will not make much difference and the work entailed in removing a tube from the center of the bank is considerable.

If the tube is to be removed and replaced, it may be cut out from the steam and water drums by using a ripping chisel and knocking in the ends, when it may possibly be pulled through the tube sheet either whole or in pieces. The new tube in some designs of White-Forster boilers may then be inserted through the tube hole in the steam drum and expanded. There is sometimes an allowance made in the size of the hole in the steam drum to allow this to be done. As a practical proposition, however, it may not be possible to insert the new tube from the steam drum. In the case of Yarrow boilers it could be done only by bending the tube considerably and then trying to straighten it as it is inserted through the hole in the tube sheet. This has been done in some cases.

However, where the tubes are bent to any considerable extent, they can not be inserted in this manner. Therefore it will be necessary to cut out a lane of tubes from one side or the other till the defective tube is accessible. It can then be cut out and new tubes inserted from outside of the drums and expanded in the usual manner.

A burst boiler tube is usually so deformed that it can not be pulled through the tube hole into the steam drum, but a corroded tube or one with pin holes that is not deformed can sometimes be removed in this way. Tube pullers can be made by which a rod or wire is attached to a plug in the lower end and this is pulled by some device such as a screw turnbuckle or jack in the upper drum. Pouring icewater into the tube under certain conditions may loosen it somewhat by causing it to contract, and lubricating the tube hole will facilitate the pulling operation.

Republic Metallurgists Lecture on Steel

Practically every phase of the metal industry is being covered in an educational program sponsored at Saginaw, Mich., by the Saginaw Malleable Iron Division, General Motors Corporation.

Among the authorities to be heard are R. S. Archer and H. W. McQuaid, both of Republic Steel Corporation. On January 20, Mr. Archer is slated to address the group on "Manufacture of Steel from Time of Tapping to Finished Stock."

"Steel Melting Practice" will be the subject on January 13 by Mr. McQuaid, Republic metallurgist who won national prominence through his research on grain size.

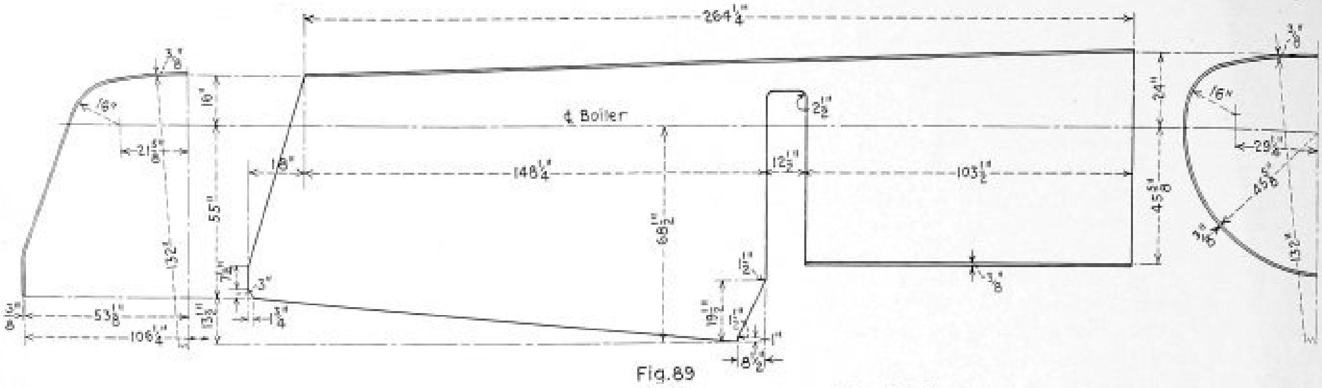


Fig.89

Locomotive firebox crown and side sheets as submitted for development

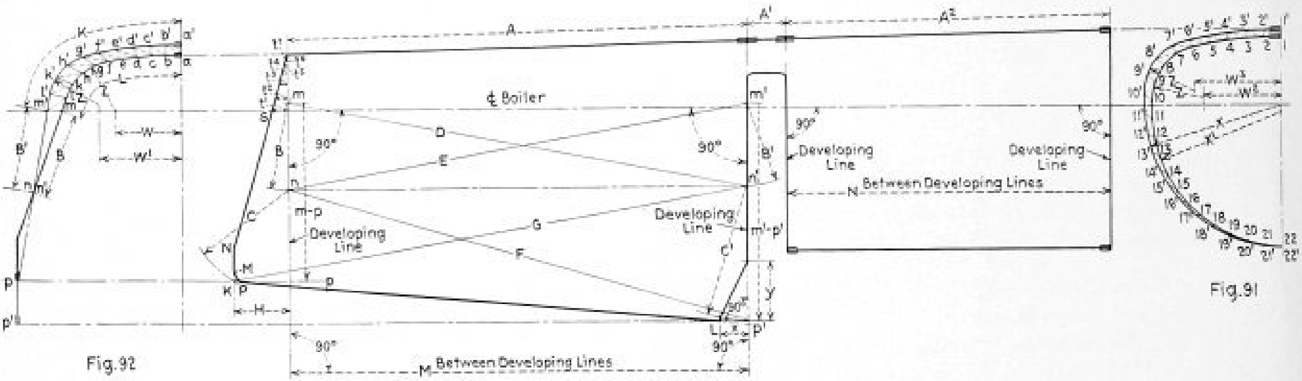


Fig.92

Fig.91

Fig.90

Development details of the crown and side sheets

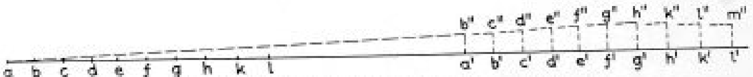


Fig.94 - Right Angle Triangles for Dotted Lines

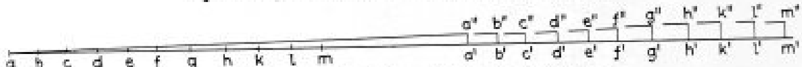


Fig.93 - Right Angle Triangles for Solid Lines

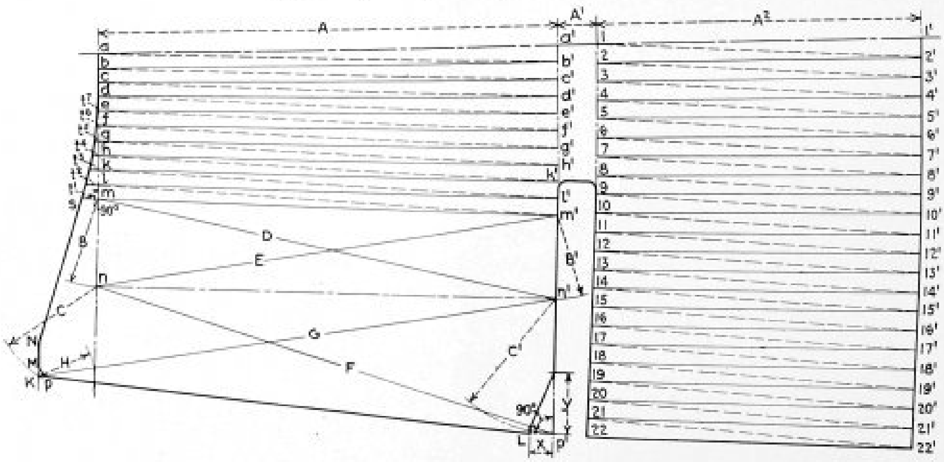


Fig.95 - Half Pattern of Crown and Sides

Development of locomotive boiler firebox in which the crown, sides and combustion chamber are all formed from a single sheet. This problem was presented for solution by one of our readers from a leading railroad, to serve as a comparison with the method actually used in constructing the firebox for a new locomotive

PRACTICAL PLATE DEVELOPMENT—X

Firebox Crown and Sides

By George M. Davies

I have been requested to include in this series on "Practical Plate Development," the development of a firebox crown, sides and combustion chamber, all to be formed from a single sheet.

The crown and sides submitted for development are illustrated in Fig. 89, which shows the side elevation, also a half view of back of the firebox and the front of the combustion chamber.

It will be noted that the distance between the sides of the firebox at the bottom remains the same front to back, and that the crown has a 132-inch radius both front and back, also that the corner radius is 16 inches both front and back, while the distance out to the center of the corner radius increases from 21⅝ inches at the back of the firebox to 29¼ inches at the front of the combustion chamber. Had this distance remained the same, the development could have been made by the projection method of developing fireboxes. However, due to this difference from front to back it will be necessary to lay out the plate by triangulation.

The first step in the development of the crown and sides by triangulation is to construct the development diagrams as shown in Figs. 90, 91 and 92.

The development diagrams are reproductions of the crown and sides shown in Fig. 89 except that all lines are taken on the neutral axis of the plates.

The crown and sides are divided into three sections as indicated by the divisions A, A' and A^2, the divisions being taken at the front of the firebox and the back of the combustion chamber.

Perpendiculars to the center lines of the boiler are drawn through the back of the firebox at the top, the front of the firebox, the back of the combustion chamber and the front of the combustion chamber. These lines will be the developing lines and are indicated as such in Fig. 90.

In Fig. 92, in addition to the projection of the back of the firebox, a projection of the front of the firebox should be made, one imposed on the other as shown. The line *a-m-p* is the contour of the developing line at the back of the firebox and *a'-m'-p'* the contour of the developing line at the front of the firebox. Also in Fig. 91 in addition to the projection of the front of the combustion chamber, a projection of the back of the combustion chamber should be made, one imposed on the other as shown, 1'-22' being the contour of the developing line at the front of the combustion chamber and 1-22 being the contour of the developing line at the back of the combustion chamber.

The next step is to establish the true dimensions of the firebox sides as shown.

On the rear firebox developing line, Fig. 90, step off from *p* the distance *m-p* equal to the exact length of *m-p*, Fig. 92, locating the point *m*, Fig. 90. Then with *m*, Fig. 90, as a center and with the trams set equal to the distance B, Fig. 92, scribe an arc cutting the back developing line locating the point *n*, Fig. 90.

Then in the same manner on the developing line at the front of the firebox, step off from *p'* the exact length of *m'-p'*, Fig. 92, locating the point *m'*, Fig. 90. Then with *m'*, Fig. 90, as a center and with the trams set equal to the distance B', Fig. 92, scribe an arc cutting the developing line at the front of the firebox locating the point *n'* on the developing line at the front of the firebox. Draw the diagonal lines D, E, F and G, as shown.

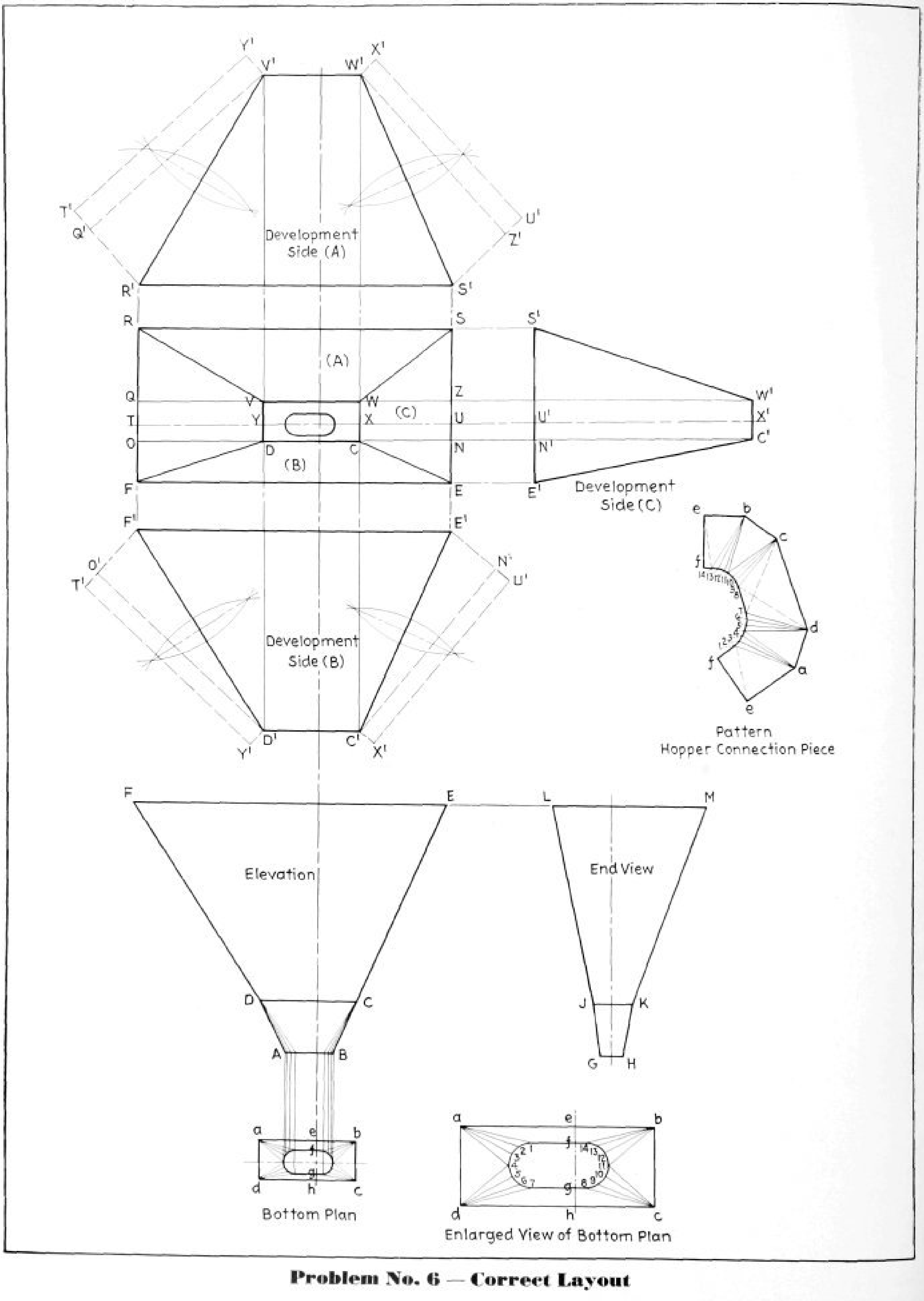
Divide the developing lines of the firebox from the vertical to the horizontal center lines of the boiler, shown as K and L in Fig. 92 into the same number of equal spaces, the greater the number of equal spaces taken, the more accurate the final development.

Number these points from *a* to *m* on L and from *a'* to *m'* on K. Connect to points *a-a'*, *b-b'*, *c-c'* to *m-m'* with solid lines and the points *a-b'*, *b-c'*, *c-d'* to *l-m'* with dotted lines as shown. Then parallel to the center line of the boiler draw lines through the points *a* to *m*, cutting the back line of the firebox and the developing line at the back of the firebox, locating the distances t', t^2, t^5, etc., as shown.

Next divide the contours of the front and back developing lines of the combustion chamber as shown in Fig. 91 into the same number of equal parts; the greater the number of equal parts taken the more accurate the final development, twenty-one being taken in this case. Number the points from 1 to 22 and from 1' to 22' as shown.

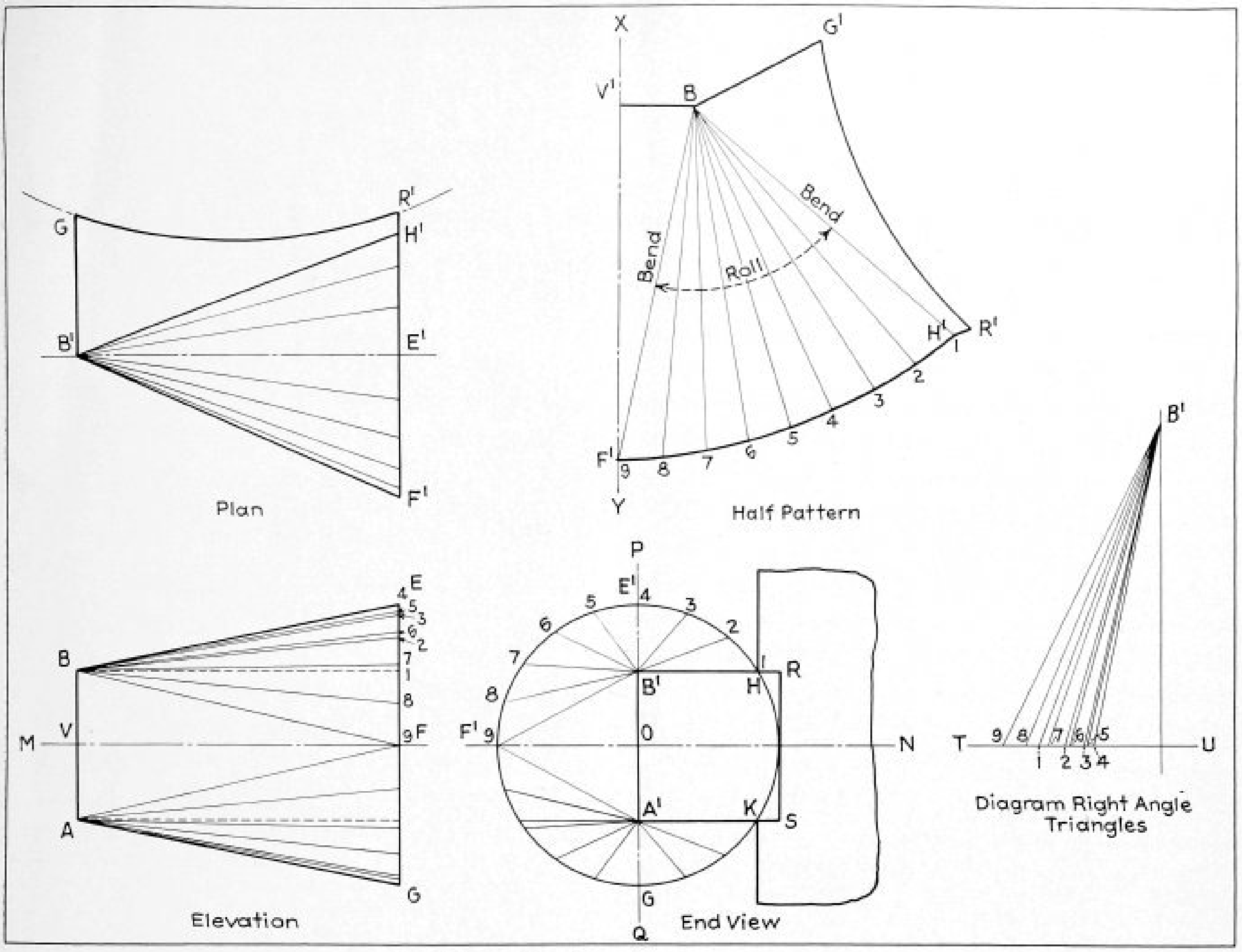
Before proceeding with the development of the pattern, it is first necessary to lay out a series of right angle triangles to obtain the true length of the solid and dotted surface lines indicated in Fig. 92. Draw a straight line as shown in Fig. 93 and step off the distances *a-a'*, *b-b'*, *c-c'*, *d-d'* to *m-m'*, each of these distances being equal to the distance M, Fig. 90. At *a'*, *b'*, *c'* to *m'* erect perpendiculars and step off on these perpendiculars the distance *a'-a''* equal to *a-a'*, Fig. 92, and *b'-b''* equal to *b-b'*, Fig. 92. Continue in this manner making *c'-c''*, *d'-d''* to *m'-m''* equal to *c-c'*, *d-d'* to *m-m'*, Fig. 92.

The distances *a-a''*, *b-b''*, *c-c''* to *m-m''*, Fig. 93, are the true lengths of the solid surface lines *a-a'*, *b-b'*, *c-c'* to *m-m'*. In like manner establish the true lengths of the dotted surface lines, Fig. 94. The bases of these triangles are taken equal to the distance M, Fig. 90, and the altitudes equal to *a-b'*, *b-c'*, *c-d'*, to *l-m'*, Fig. 92, true lengths of the dotted surface lines being shown as *a-b''*, *b-c''*, *c-d''* to *l-m''*, Fig. 94.



Problem No. 6 — Correct Layout

Solution of the practice "Hopper" problem which appeared on page 240 of the September, 1935, issue



Problem No. 7 — Correct Layout

Solution of practice problem "Air Duct Shoe," which appeared on page 316 of the November, 1935, issue

CONSTRUCTING THE PATTERN

Before constructing the pattern it will be noted that the vertical center line of the boiler divides the firebox into two symmetrical halves, therefore a pattern of one half can be duplicated for the other half.

Draw a straight line as shown in Fig. 95 and step off the distances *A*, *A'* and A^2 being the exact length of *A*, *A'* and A^2, Fig. 90.

The distance *A* will also be exactly equal in length to the solid surface line *a-a″*, Fig. 93, locating the points *a-a'*, Fig. 95.

With *a'*, Fig. 95, as a center and with the dividers set equal to the distance *a'-b'*, Fig. 92, scribe an arc, then with *a*, Fig. 95, as a center and with the trams set equal to the distance *a-b″*, Fig. 94, scribe an arc cutting the arc just drawn locating the point *b'*, Fig. 95.

Then with *a*, Fig. 95, as a center and with the dividers set equal to the distance *a-b*, Fig. 92, scribe an arc. With *b'*, Fig. 95, as a center and with the trams set equal to the distance *b-b″*, Fig. 93, scribe an arc cutting the arc just drawn locating the point *b*, Fig. 95.

Continue in this manner, making *b'-c'*, *c'-d'* to *l'-m'* equal to their corresponding distances in Fig. 92 and the distances *b-c*, *c-d* to *l-m* also equal to their corresponding distances in Fig. 92. The length of the dotted and solid surface lines are taken equal to their corresponding lines in Figs. 93 and 94 until the line *m-m'*, Fig. 95, is drawn.

Erect perpendiculars to *a-m* at *e*, *f*, *g*, *h*, *k*, *l* and *m* and step off the distances t', t^2, t^3, to t^7 equal to these corresponding lengths in Fig. 90. Draw a line through these points as *a-s*.

With *m*, Fig. 95, as a center and with the trams set equal to *B*, Fig. 90, scribe an arc; then with *m'*, Fig. 95, as a center and with the trams set equal to *E*, Fig. 90, scribe an arc cutting the arc just drawn, locating the point *n*, Fig. 95. Continue in this manner taking the distances equal to their corresponding distances in Fig. 90, locating the points *n'*, *p'* and *K*, Fig. 95.

Connect *m'-p'*, Fig. 95, and erect a perpendicular to it at *p'* and step off the distance *x* equal to *x*, Fig. 90, locating the point *L*, Fig. 95.

Form the corner making *y* equal to *y* in Fig. 90. Connect *K-L*, completing the bottom line of the development.

Next with *K* as a center and with *H*, Fig. 90, as a radius, scribe an arc. Draw a line through point *n* tangent to the arc just drawn. *K-N* is drawn parallel to this line. *K-N*, *K-M* and *K-P* are taken equal to *K-N*, *K-M* and *K-P* in Fig. 90. Connect the points *P*, *M*, *N* and *s* completing the half pattern of the firebox.

The combustion chamber is developed in same manner as the crown, completing the pattern. Right angle triangles are made to obtain the true length of the solid and dotted surface lines shown in Fig. 91. The lengths 1-2, 2-3, 3-4 to 21-22 and 1'-2', 2'-3', 3'-4' to 21'-22', Fig. 95, being taken equal to the same lengths in Fig. 91.

In starting the development of the combustion chamber the distance a'-1 is taken equal to the distance A', Fig. 90. The true length of the solid surface line 1-1′, Fig. 91, is exactly the same length as A^2, Fig. 90.

The development of the combustion chamber is entirely independent of the firebox after the point 1 is correctly located in its relation to point a', as shown in Fig. 95.

Proposed Revisions and Addenda to the A.S.M.E. Boiler Construction Code

It is the policy of the Boiler Code Committee of the American Society of Mechanical Engineers to receive and consider as promptly as possible any desired revision of the rules and its codes. Any suggestions for revisions or modifications that are approved by the committee will be recommended for addenda to the code, to be included later in the proper place in the code.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticism and approval from any one interested therein. It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the council of the society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the committee for consideration.

PAR. P-22. Add the following as the third section:

THE MAXIMUM ALLOWABLE WORKING PRESSURE FOR COPPER TUBES OR NIPPLES (CONFORMING TO SPECIFICATION S-22) USED IN WATER-TUBE OR FIRE-TUBE BOILERS, SHALL BE DETERMINED BY THE FORMULA GIVEN IN PAR. P-26. SUCH TUBES SHALL NOT BE USED FOR PRESSURES EXCEEDING 250 LB. PER SQ. IN., NOR FOR TEMPERATURES EXCEEDING 406 F. VALUES OF "S" FOR COPPER TUBES ARE TO BE AS GIVEN IN TABLE P-7½. COPPER TUBES SHALL NOT BE USED UNDER EXTERNAL PRESSURE WHEN THE RATIO OF WALL THICKNESS DIVIDED BY THE OUTSIDE DIAMETER FALLS BELOW 0.04.

PAR. P-23. Revise first sentence to read:

In determining the thickness to be used for IRON OR STEEL pipes at different pressures and temperatures the following formulas are to be used:

Add a new section to read:

IN DETERMINING THE THICKNESS TO BE USED FOR BRASS OR COPPER PIPES AT DIFFERENT PRESSURES AND TEMPERATURES USE THE FORMULA AND "S" VALUES CALLED FOR IN PAR. P-26.

TABLE P-6. Omit references and values for Brass and Copper.

PAR. P-24. Revise the second sentence to read:

The maximum allowable working pressure for feedwater piping and/or water piping below the water line shall be taken as 80 percent of that for steam piping of the corresponding sizes as given by the rules in Pars. P-23 AND P-26 and using the "S" values, etc.

PARS. P-26 and U-20*c*. Insert the following as Pars. P-26 U-20*c*:

P-26 (U-20*c*). *Non-Ferrous Tubes and Pipes.* Maximum allowable working pressures in pounds per square inch for seamless non-ferrous tubes and pipes, conforming to specifications given in Section II of the code, are to be determined by the following formula

$$P = \frac{2St}{D}$$

where P. = maximum allowable working pressure, lb. per sq in.,
t = minimum wall thickness, in.,
S = maximum allowable working stress from Table P-7½ (U-3½), lb. per sq. in.,
D = outside diameter of pipe, in.

The formula is subject to the following restrictions:

(*a*) Applicable only to diameters ½ in. outside diameter, outside diameter to 6 in. outside diameter, inclusive, and for wall thicknesses not less than No. 18 Bwg (0.049 in.).

(*b*) Additional wall thickness should be provided where corrosion, or wear due to cleaning operations, is expected.

(*c*) Where tube ends are threaded, additional wall thickness of $\frac{0.8}{\text{number of threads}}$ is to be provided.

(*d*) The requirements for rolling or otherwise setting tubes in tube plates, may require additional wall thickness.

PAR. P-321. Insert the following after the first sentence:

WATER COLUMNS MADE OF CAST IRON EQUAL TO SPECIFICATIONS S-13 MAY BE USED FOR MAXIMUM BOILER PRESSURES NOT EXCEEDING 250 LB. PER SQ. IN. WATER COLUMNS MADE OF MALLEABLE IRON EQUAL TO SPECIFICATION S-15 MAY BE USED FOR MAXIMUM BOILER PRESSURES NOT EXCEEDING 350 LB. PER SQ. IN. FOR HIGHER PRESSURES STEEL CONSTRUCTION SHALL BE USED.

TABLE P-7½ (U-3½) VALUES OF FACTOR *S* TO BE USED IN THE FORMULA GIVEN IN PAR. P-26 (U-20*c*)

Material	Spec. No.	For temperatures not exceeding deg. F. 150	250	350	400*	450
Muntz metal-tubing: High brass tubing and condenser tubes	S-24 S-30	5000	4000	2500	....	....
Red brass tubes	S-24	6000	5500	5000	4500	....
Copper tubes and pipes	S-22 S-23	6000	5000	4500	4000	....
Brass 70-30 condenser tubes	S-29	6000	5000	4500	4000	....
Admiralty tubing and condenser tubes	S-24 S-31	7000	6500	6000	5500	4500

* Stresses in this column may be used with saturated steam at 250 lb. per sq. in. gage pressures.

Fig. 1.—Arc-welding the roof plating of a 200,000 gallon rectangular bulk storage tank

Arc Welding Speeds Tank Work

Record construction speed was recently made at Brooklyn, New York, when three 200,000-gallon rectangular bulk storage tanks were completed a full month ahead of schedule. These tanks were built by the J. K. Welding Company of New York City for the Colonial Beacon Oil Company, Inc., subsidiary of the Standard Oil Company (N. J.).

Each of the tanks is 60 feet long by 38 feet wide by 12 feet deep and contains two compartments. A total of 241 tons of steel was required for construction. This was made up of 180 tons of steel plate, 60 tons of angles and 1 ton of fittings.

Construction was by the Truss-Weld patented system of framing developed by Johannes Kjestead, consulting welding engineer of New York City.

The shell of each tank is 3/8-inch plate, reinforced by steel braces spaced on 2-foot centers each way. The horizontal braces are angles, 1¼ inches by 1¼ inches by 5/16 inch. Vertical braces are angles 1¼ inches by 1¼ inches by ¼ inch. The corner angles are 3 inches by 3 inches by 3/8 inch.

In welding the trusses, the entire assembly was placed in a jig to insure accurate spacing, alinement and squareness. The trusses were welded up in sections and properly positioned on the tank bottom, which consists of steel plate 3/8-inch thick welded together and resting on

Fig. 2.—Three tanks completed ready for the installation of piping. All welding was done with the shielded-arc process

a concrete base. When the entire truss framing was properly placed, all trusses were tied together by angles extending completely across the framing at the intersection of each vertical and horizontal member, and welded to both verticals and horizontals.

When the entire frame had been tied together into one integral, the vertical members were welded to the steel bottom. The next step in construction consisted of attaching the 3/8-inch side and end plating. Welding of the roof plating is shown in Fig. 1. Fig. 2 shows the three tanks completed ready for installation of piping. Fig. 2 also shows the concrete wall surrounding the tanks.

Bulk storage plants in metropolitan New York are adopting rectangular tanks increasingly. In congested districts, it is often possible to obtain greater storage capacity than would be possible with a cylindrical unit. In addition to providing greater capacity for a given space, the rectangular tank permits savings on concrete and reduces excavation. These savings make it possible to install rectangular units at considerably less cost.

The fast welding permitted by modern shielded-arc equipment is to be noted in the short time required to build these large tanks. Exactly seven weeks after the first shipment of plate arrived on the building site, the last tank was tested and accepted. All welding was done with shielded arc equipment supplied by The Lincoln Electric Company, Cleveland.

Electrically Fed Plate Planer

Special heat-treated armor plates such as are used by the Government in the construction of battleships are no problem for the two new electrically fed 36-foot plate planers recently completed by the Baldwin-Southwark Corporation, Philadelphia, for the Philadelphia Navy Yard. Smoothly the carriage glides along its brass gibs or shoes at a variable rate of 15 to 45 feet per minute as the hard tool steel bits plane 1/100 inch to 1/4 inch from these heavy steel plates at widths up to 1 inch.

Plates varying up to 5 inches in thickness and from 6 to 36 feet in length are all cut, scarfed, or beveled to 0.001 inch accuracy by this tremendous machine. Keyways or interlocking joints on deck plates and the like are cut to depths varying from 3/4 inch to 1 1/2 inch. The tool adjustment vertically is 11 1/2 inches while the maximum horizontal adjustment is 19 inches.

After being hoisted to the working table and set as desired, the plates are locked down by twenty-four pneumatic hold-downs or grips which are actuated in the Philadelphia Navy Yard by 100 pounds of compressed air. These clamps exert a pressure of 120 tons on the plate.

Then the 1 1/2-inch hard steel cutting tools are selected and inserted. The feeder is set at the desired depth and the 50-horsepower electric motor is turned on.

Steadily back and forth the carriage travels, automatically reversing itself at the end of each stroke. Each time the tool feeds itself to the predetermined depth. To Baldwin-Southwark goes the distinction of being the first to utilize this electrical feed feature on a plate planer.

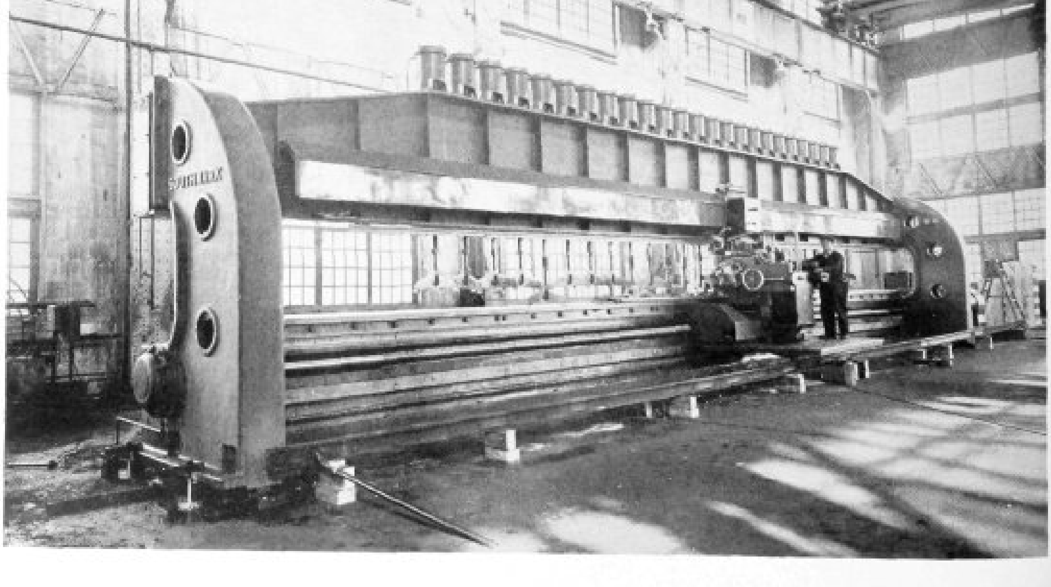
The drive screw, made in one piece, is 7 inches in diameter and is 59 feet overall, including the bearings. It has a quintuple thread and runs on roller bearings. The threading of this screw was done in the shops of the Southwark Division and is indicative of the facilities of this century old establishment which are offered for the construction of large and special equipment.

So enormous is this machine, that it is anchored in 5 feet of concrete which was poured on 30 pilings driven 60 feet into the ground. The planer is 60 feet in length and stands slightly over 15 feet above the floor level. Approximately a foot and a half of the machine is below the floor level. The weight of the plate planer is in excess of 210,000 pounds.

Heating Engineers to Meet This Month

Leaders of the heating, ventilating and air conditioning profession and allied industries will gather in Chicago during the week of January 27 for the 42nd Annual Meeting of the American Society of Heating and Ventilating Engineers to be held at the Palmer House.

The meeting will be opened with a business session on Monday, January 27, by President John Howatt of Chicago, and reports of the officers and committees will be presented. The results of the annual election will be announced. The results of many months research carried on at the Society's laboratories in the U. S. Bureau of Mines, Pittsburgh, Pa., and at various cooperating institutions will be presented to the members.



Baldwin-Southwark plate planer, built for use in fabricating battleship and other plates at the Philadelphia Navy Yard

Republic Office in Cleveland Changed

The Cleveland District Sales Office of Republic Steel Corporation has been removed from the Union Trust Building to 920 Republic Building, according to an announcement by N. J. Clarke, vice-president in charge of sales for Republic. W. E. Collier continues in charge of the office as district sales manager.

The New A.S.H.V.E. Guide 1936

In the fourteenth edition of "The Guide" issued by the American Society of Heating and Ventilating Engineers, New York, a large amount of new and revised authoritative engineering data have been assembled from a variety of sources on the subjects of heating, ventilating and air conditioning increasing the contents of the Technical Data Section to 792 pages. The leading engineers and technicians who compiled this new volume have drawn upon the latest researches of the A. S. H. V. E. Laboratory and co-operating institutions with correlating design and application data based on the most recent engineering trends in this expanding industry. The Problems in Practice introduced last year have been continued for each chapter with new and practical examples to amplify the text material.

Four new chapters have been added to The Guide 1936 to fulfill the requests for more detailed information on the subjects of refrigeration, drying, electric motors and railway air conditioning.

Another feature of The Guide 1936 is the new table of Saturated Water Vapor extending over a range from minus 130 to plus 200 F. with heat content values based on the varying values of specific heat for air.

In addition to the new material which has been added, the previous chapters have been carefully checked and reviewed and in some cases the text has been completely rewritten so as to conform to more recent engineering practices.

Westinghouse Celebrates Anniversary

The year 1936 is a "golden jubilee" year for Westinghouse, January 8 having been the fiftieth anniversary of the founding of that company by George Westinghouse on January 8, 1886, when the charter was granted to the Westinghouse Electric Company.

In commemoration of its fiftieth birthday Westinghouse, on the night of January 8, held a "family" gathering in Pittsburgh, Pa., for the 12,000 employes in that district. Simultaneously a similar meeting of Westinghouse employes was held in every important Westinghouse factory and office in the country.

A unique feature of this "family" gathering of 40,000 employes was that the complete Pittsburgh program was broadcast to all of the other meetings in plants and districts over Westinghouse's own short wave transmitter at W8XK. The program was sent out simultaneously on two wave lengths, 25.26 and 48.83 meters, and was picked up in plants and offices all over the United States and also in foreign countries.

At Pittsburgh prominent speakers reviewed the important contributions that Westinghouse has made to the progress of industry and to the welfare of humanity and presented a forecast of the future of the electrical industry. A Westinghouse institutional sound picture, "The New Frontiers," prepared especially for its golden jubilee, was shown to employes for the first time on this occasion. Music was furnished by Westinghouse's own organizations—the Westinghouse Band, the Westinghouse Chorus and the Westinghouse Kilty Band.

As far as is known this was the first mass gathering of all employes of a company throughout the world by means of short wave radio over its own station.

Flue Openings in Heads of Boilers

In a recent letter to members of his staff, shipbuilders, boiler manufacturers and other interested parties, Joseph B. Weaver, director of the Bureau of Navigation and Steamboat Inspection, dealt with the subject of flue openings in heads of externally fired flue boilers as follows:

It has been brought to the attention of the bureau that the requirements of Rule II, Section 6, Paragraph C-6-3 (g), page 59, work a hardship on the construction of externally fired flue boilers, because, as written, the rule would imply that flue openings in the heads used on this type of boiler would have to be flanged to an inner radius equal to three times the thickness of the heads. This would seriously affect the spacing of the flues and would necessitate omitting a considerable part of the heating surface, and thereby impair the efficiency of the boiler as a steam generator.

It was not the intent of the committee, when promulgating these rules, to apply an inner radius on the bend of the flange equal to three times the thickness of the plate at the flue openings. It was, however, intended that this radius should apply to the flange formed on the outer edge of the head at the point where the head is attached to the shell. Therefore, the bureau has interpreted this rule to mean that the flange on the edge of the head shall be formed to an inner radius at least equal to three times the thickness of the plate and the flange of the flue openings shall be formed to an inner radius at least equal to one and one-half times the thickness of the plate.

At the annual meeting of the Board of Supervising Inspectors, this matter will be taken up with a view to clarifying this paragraph.

Seamless Alloy Tubes for Special Service

The Babcock & Wilcox Tube Company, Beaver Falls, Pa., announces the commercial production of seamless tubes and pipe of a highly alloyed steel containing 25 percent chromium and 20 percent nickel. These products are available hot-finished in sizes up to 6 inches outside diameter and cold-drawn in smaller sizes. The company has been closely identified with the development of alloy-steel tubular products for severe service requirements and extends its range of analyses with this new alloy, which is being marketed under the trade name B&W Croloy 25-20.

This alloy has a high degree of oxidation resistance and is suitable for continuous operation at temperatures up to approximately 2100 degrees F. It is a ductile material possessing greater creep strength and resistance to oxidation at high temperatures than is possessed by alloys now commercially available in the form of seamless tubing. Its properties are such that the alloy will undoubtedly find a field of usefulness in high-temperature cracking, polymerization and other refinery operations, as well as for high-temperature equipment such as recuperators, thermocouple protection tubes, valves, and heat-resistant tubular members.

This alloy has been available for high-temperature application in sheet, plate, rods, and castings, but has not, heretofore, been made available in seamless tube form except through a tedious forging and boring process.

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

VOLUME XXXVI NUMBER 1

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Contents

Tests for Welding Operators

On the matter of qualifying tests for welders, Joseph B. Weaver, director of the Bureau of Navigation and Steamboat Inspection, recently issued a circular letter to shipbuilders, shipowners, supervising, traveling, local and assistant inspectors, as follows:

The Bureau Circular Letter No. 5, dated October 31, 1935, fixed the date of January 1, 1936, as the time limit for the qualification of welding operators.

In view of the fact that the National Bureau of Standards has been unable to complete the qualifying tests within the time limit assigned, it is necessary that this time be extended until the specimens now on hand have been tested. Firms who desire to have their welding operators qualify are urged to forward their specimens at once, if they have not previously done so, for the reason that as soon as the tests on hand are completed, a definite date will be established for the qualification of welding operators, after which, operators who have not passed the qualifying tests will not be permitted to work on boilers or pressure vessels subject to the jurisdiction of the bureau.

Trade Publications

Dust Collectors.—A folder illustrating the advantages of dust-control units in many industries has been made available to those interested by the Pangborn Corporation, Hagerstown, Md.

Nickel Cast Iron.—A data sheet on the properties of nickel cast iron has been issued by the International Nickel Company, Inc., New York. Designers of equipment subject to wide variations of temperature will find the data contained of special interest.

Welding Equipment.—Under the title "Weld It Well," the Harnischfeger Corporation, Milwaukee, Wis., has published a 24-page bulletin covering the complete line of P & H-Hansen arc welders from 50 to 800-amperes units as well as welding fixtures and accessories. Condensed specifications and performance data are included.

Expansion Joints.—A bulletin illustrating and describing the various all-steel cylinder guided expansion joints produced by the Yarnall-Waring Company, Philadelphia, is now available. Yarway expansion joints include the Gun-Pakt type, Gland-Pakt joint, welding type joints, and numerous flanged expansion joints. A price list of all these is included in the bulletin.

Non-Sparking Tools.—The Superheater Company, New York, has recently sent out a catalogue on Elesco non-sparking tools. The use of these tools, it is stated, will prevent the emission of sparks with attendant fire or explosion where there are inflammable or explosive gases. Special hardening alloys are incorporated in the cutting tools.

Properties of Toncan Iron.—A folder containing a fund of condensed, up-to-date information on rust-resisting Toncan copper molybdenum iron has recently been issued by the Republic Steel Corporation, Massillon, O. Two important sections of this folder give complete physical properties and physical constants of this corrosion-resisting alloy iron.

Nickel-Clad Steel.—The Lukens Steel Company, Coatesville, Pa., is now distributing a bulletin describing applications of nickel-clad steel which provides corrosion-resistance at economical cost. Brief details are given of the chemical and physical properties of the material, the method of cladding employed, illustrations of many vessels and products fabricated from this material and an inclusive list of applications.

Watertube Boilers.—A new type watertube boiler, built by E. Keeler Company, Williamsport, Pa., is described in a bulletin recently issued by the company. In a recent test conducted on this boiler, an efficiency of 82.63 percent was obtained when working the boiler at 203 percent of its rating capacity. On similar tests an efficiency of 84.5 percent has been obtained with the boiler working at 125 percent of its rating.

Sectional-Header Boilers.—A catalogue illustrating and describing details of sectional-header type boilers as built by Combustion Engineering Company, New York, for a wide range of steam pressures, capacities and different methods of fuel firing, has recently been issued. In addition to details of design, cross-sections of numerous installations are included, as well as shop views showing the fabrication of such boilers and their inspection. In these boilers fusion welding is standard and riveted construction optional.

Questions and Answers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Patching a Crown Sheet

Q.—Would it be permissible to remove a Nicholson thermic syphon from the crown sheet of a locomotive firebox and apply a patch by welding, as shown on the attached blue print? F. J.

A.—It would be permissible to remove a Nicholson thermic syphon from the crown sheet of a locomotive and apply a patch by welding.

The illustration of the patch as submitted with the question would not be satisfactory as no provision has been made for additional staybolts to support the crown sheet in the area that was occupied by the thermic syphon.

The recommended practice for welding fireboxes, is to keep all longitudinal welds 12 inches below the top of the crown sheet. This would require that the crown sheet be renewed to a point 12 inches below the top of the crown when removing the thermic syphon.

It is permitted to weld in syphons due to the fact that the action of the syphon tends to keep the crown covered with water at all times, thereby reducing the possibility of failure due to low water.

Expansion Joint for Miniature Scotch Boiler

Q.—If I may encroach upon your valuable time I would like to ask the following questions concerning a miniature Scotch boiler I am constructing:

1. The sides or wrapper plates of the combustion chambers are to be 3/16-inch thick; in a test of this plate in a span of 2¾ inches (width of wrapper plate in model) I got a deflection of 0.007-inch under 350 pounds hydraulic; the conditions are practically the same as a beam fixed at both ends uniformly loaded. So I have decided to put in one row of staybolts in the center of the plate. What do you think of this?

2. The tubes are to be 5/16-inch outside diameter, Shelby seamless No. 18 gage and must be tight when expanded, as there is no way of getting at them when the heads are in place. What do you think of brazing around the ends of the tubes after expanding?

3. I should like to use stainless steel for the main head to head staybolts. Do you think there is enough difference in the coefficient of expansion of stainless and soft steel to make the stainless bolts leak?

I should state that the dimensions of the boiler are: Shell, 11 inches long outside the heads; ⅛-inch thick (National seamless); 12 inches inside diameter; heads, ¼-inch thick threaded into shell with male thread on heads, circumferential head seams electrically welded on outside. Two furnaces 3⅛ inches inside, ⅛ inch thick ribbed on outside, pressure 150 pounds gage.

I am enclosing print of an expansion piece to be used between end of furnaces and combustion chamber. By the way, is there enough differential expansion between the furnace and tubes to cause trouble without provision being made for it? It would be most marked in getting up steam, I suppose. F. D. H.

A.—(1) The allowable spacing of stays for 3/16-inch plate at 150 pounds working pressure would be 2 9/16 inches.

Although the conditions under which the sides of the combustion chamber are supported may not be the same as for stayed surfaces, the above would indicate that it would be preferable to apply a row of staybolts as additional support for the sides of the combustion chamber.

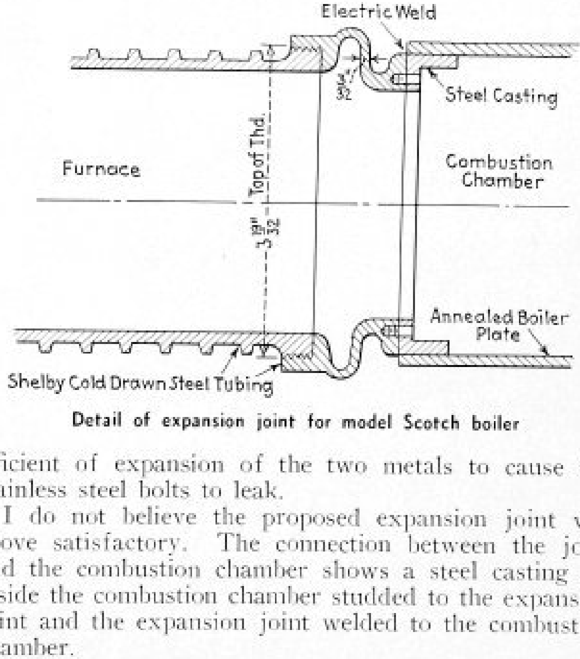
(2) The A. S. M. E. Code for Miniature Boilers states that fire tubes less than 1½ inches, shall be expanded and beaded or expanded and welded into the sheet.

(3) The co-efficient of expansion for stainless steel is given in Marks Mechanical Engineer's Handbook as:—Average co-efficient of expansion from 60 to 1100 degrees F.

$$6.5 \times 10^{-6} \text{ which equals } 6.5 \times \frac{1}{10^{6}} = \frac{6.5 \times 1}{1{,}000{,}000} = 0.0000065 \text{ co-efficient of expansion for stainless steel.}$$

The co-efficient of expansion for soft steel varies from 0.00000617 to 0.00000673 depending upon the chemical composition of the steel.

I do not believe there is enough difference in the co-



Detail of expansion joint for model Scotch boiler

efficient of expansion of the two metals to cause the stainless steel bolts to leak.

I do not believe the proposed expansion joint will prove satisfactory. The connection between the joint and the combustion chamber shows a steel casting set inside the combustion chamber studded to the expansion joint and the expansion joint welded to the combustion chamber.

Could not the expansion joint have been set into the combustion chamber and welded to same without the use of the steel casting ring?

The co-efficient of expansion for the various grades of steel varies so little that I do not believe the expansion joint would be required.

Wagon-Top Boilers

Q.—I would like you to send me as early as possible a complete explanation of the advantages and disadvantages of taper boilers—those with a taper on the top of the boiler and those on the bottom. Could you also trace back for me the first users and date of these taper boilers? J. W. T.

A.—Locomotive boilers having a taper on the top, commonly known as the wagon-top boilers were first built at the Roger Locomotive Works in 1850, according to the book "Locomotives and Locomotive Building" published in 1886.

This book states, in connection with wagon top boilers, that, "the tops of the furnaces in boilers of this kind were also semi-cylindrical but they were made considerably higher than the barrels of the boiler. The exact reason for first adopting this form of boiler is not known, but it had the advantage of giving more steam room and allowed the use of more tubes and consequently more heating surface than could be used in a flush topped boiler. The wagon-top also gives more room for workmen on the inside of the boiler over the crown sheets and it thus facilitates construction and repairs."

At the present time wagon-top boilers are not used as extensively as straight-top boilers due to the increased size of the boilers, raising the top so high above the rails that the taper is entirely eliminated, the barrel of the boiler being as large in diameter as the firebox.

From the same reference, we find that a boiler having a taper on the bottom directly ahead of the throat sheet was built at the Roger Locomotive Works in 1871 for the Cumberland Valley Railroad.

This boiler had a Buchanan firebox which necessitated the tapering of the course ahead of the firebox.

Books on Boilers

Q.—After reading your questions and answers pertaining to boilers, conducted in the BOILER MAKER AND PLATE FABRICATOR I wonder if you would be able to recommend any books in which I could obtain information on the design and calculation of boilers. I am particularly interested in locomotive boilers. J. A. G.

A.—(1) For rules and formulas covering boiler calculations:

The A. S. M. E. Boiler Code, Section III, published by the American Society of Mechanical Engineers, 29 West 39th St., New York City.

(2) For basic design and theory of constructional details:

Design of Steam Boilers and Pressure Vessels, by Haven and Swett, published by John Wiley & Sons, Inc., New York City.

(3) A practical locomotive boiler book:

A study of the Locomotive Boiler, by Lawford H. Fry, published by the Simmons-Boardman Publishing Company, New York City.

(4) For the development of the Plates of a Locomotive Boiler:

Laying out for Boiler Makers, published by the Simmons-Boardman Publishing Company, New York City.

Hammered Head Crown Stays

Q.—Fig. 1 shows a new design of securing crown stays, as adopted in some locomotive type boilers (pressure, 180 pounds per square inch) on the railroad where I am employed. The object of this design is to overcome corrosion, in the form of grooving, of the firebox crown plate around the crown stays on the fire side. In my opinion, I do not consider the support given by this type of head to be adequate, owing to the liability of the plate to stretch if buckled, thus leaving the screw thread hold ineffective as shown in Fig. 2, in which the threads in the buckled plate have been pulled away from the screw stay. Furthermore, with this design the crown is more likely to collapse in the event of a low water failure. As an interested subscriber to your paper, I shall be grateful for your opinion in this matter. T. N.

A.—The crown stay illustrated in the sketch appears to be a straight bolt with the ends riveted over.

The use of hammered head crown stays is becoming more and more general, due to the fact that they are more economical to apply and easier to maintain. They originally came into general use because of the need of a smaller head than the button head type in oil-burning locomotives. The large amount of iron in the button head type bolt becomes overheated and wastes away due to high temperatures of the fire, causing the bolt in many cases to become weakened.

Experience has demonstrated that the hammered head crown stay, while not as strong as the button head type, has ample strength under ordinary working conditions; that is with water over the crown sheet, as it will stand from 18,000 to 20,000 pounds before pulling through the crown sheet. Under ordinary conditions all the bolt is called upon to stand with 180 pounds pressure with a spacing of 4 inches by 4 inches is 2880 pounds.

Several years ago a committee of the Master Boiler Makers Association conducted a test to determine the strength of button head type and hammered head crown bolts of various tapers under similar conditions which would exist when crown sheets are overheated, as a result of low water while under pressure.

A brief summary of the findings of this committee are as follows: "These tests show how much longer

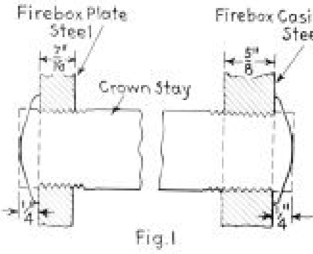


Fig. 1

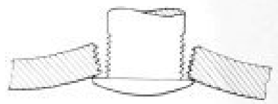


Fig. 2

the button head type crown bolts hold compared with the hammered head type when the crown sheet is overheated. It also demonstrates an important and interesting feature regarding the holding power of the taper on hammered head crown bolts. In this particular test your attention is directed to tests Nos. 3 and 4, compared with tests Nos. 5, 6, 7 and 8. It demonstrates that the $1\frac{1}{4}$-inch diameter straight hammered head crown bolt will support the crown sheet when overheated under approximately the same conditions as the $1\frac{1}{8}$-inch diameter hammered head crown bolt with $1\frac{1}{2}$ or 2-inch taper in 12 inches. Generally speaking, it can be said that increased diameter of crown bolt at crown sheet fit gives approximately the same holding power in a heated sheet as increased taper on crown bolt.

"It is well known that no crown bolt will hold up the crown sheet when it becomes overheated beyond certain limits. Tests, however, prove that the average size button head type of bolt will support crown sheet under 200 pounds working pressure until it develops a temperature of 1364 degrees F., while the average hammered head type bolt will fail under 1237 degrees temperature."

As indicated in the statement above, a large majority of the locomotives in use today are equipped with hammered head crown bolts.

Fig. 1 as submitted illustrates a straight bolt. The general practice is to use a taper head bolt for the following reasons:

1. They have sufficient strength.
2. The bolt with the taper can be applied more economically.
3. They tighten in the sheet more readily and are not as easily stripped.
4. Can be securely fitted in the crown sheet regardless of the degree of radius.
5. Give less trouble leaking than button head bolts.
6. A riveted head bolt is not damaged from calking as easily as a button head type.
7. Can be manufactured at less cost than the button head type.
8. Savings effected by one tap and reamer accommodating several sizes of bolts, thereby reducing tool expense.
9. Because of taper accommodating different sizes, a smaller stock of hammered head bolts is required.
10. This bolt permits a more even head condition on the fire side of the crown sheet, which reduces the amount of clinker and dirt adhering to the sheet.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—John M. Hall, Washington, D. C.
Assistant Chief Inspector—J. A. Shirley, Washington.
Assistant Chief Inspector—J. B. Brown, Washington.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Director—Joseph B. Weaver, Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—D. S. Jacobus, New York.
Acting Secretary—M. Jurist, 29 W. 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—William H. Furman, Albany, N. Y.
Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.
Vice-Chairman—F. A. Page, San Francisco, Cal.
Statistician—L. C. Peal, Nashville, Tenn.

International Brotherhood of Boiler Makers, Welders, Iron Ship Builders and Helpers of America

International President—J. A. Franklin, Suite 522, Brotherhood Block, Kansas City, Kansas.
Assistant International President—J. N. Davis, Suite 522, Brotherhood Block, Kansas City, Kansas.
International Secretary-Treasurer—Chas. F. Scott, Suite 506, Brotherhood Block, Kansas City, Kansas.
Editor-Manager of Journal—L. A. Freeman, Suite 524, Brotherhood Block, Kansas City, Kansas.
International Vice-Presidents—Joseph Reed, 3753 S. E. Madison Street, Portland, Ore.; W. A. Calvin, Room 402, A. F. of L. Building, Washington, D. C.; Harry Nicholas, 6215 S. Benton Blvd., Kansas City, Mo.; W. E. Walter, 637 N. 25th Street, East St. Louis, Ill.; J. H. Gutridge, 2178 South 79th Street, W. Allis, Wis.; W. G. Pendergast, 1814 Eighth Avenue, Brooklyn, N. Y.; W. J. Coyle, 424 Third Avenue, Verdun, Montreal, Quebec, Can.; A. M. Milligan, 262 Trent Avenue, East Kildonan, Man., Can.; J. F. Schmitt, 28 S. Roys Street, Columbus, Ohio; William Williams, 1615 S. E. 27th Avenue, Portland, Ore.

Master Boiler Makers' Association

President: O. H. Kurlfinke, boiler engineer, Southern Pacific Company, 65 Market Street, San Francisco.
First Vice-President: Franklin T. Litz, foreman boiler maker, C. M. St. P. & P. R. R., Dubuque, Ia.
Second Vice-President: Ira J. Pool, field service representative, National Tube Company, 5610 Merville Avenue, Baltimore, Md.
Third Vice-President: L. E. Hart, foreman boiler maker, Atlantic Coast Line, Rocky Mount, N. C.
Fourth Vice-President: William N. Moore, general boiler foreman, Pere Marquette R. R., 625 College Avenue, S. E., Grand Rapids, Mich.
Fifth Vice-President: Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis (Big Four), 814 Big Four Building, Indianapolis, Ind.
Secretary: Albert F. Stiglmeier, general foreman boiler maker, New York Central, West Albany Shops, 29 Parkwood Street, Albany, N. Y.
Treasurer: William H. Laughridge, retired general boiler inspector, Hocking Valley R. R., 537 Linwood Avenue, Columbus, O.
Executive Board—Chairman: J. L. Callahan, general boiler inspector, Chicago Great Western, Oelwein, Ia.

American Boiler Manufacturers' Association

President—Owsley Brown, Springfield Boiler Company, Springfield, Ill.
Vice-President—S. H. Barnum, The Bigelow Company, New Haven, Conn.
Secretary-Treasurer—A. C. Baker, 709 Rockefeller Building, Cleveland.
Executive Committee (Three years)—Walter F. Keenan, Jr., Foster Wheeler Corporation, New York. E. E. Knobloch, Union Iron Works, Erie, Pa. C. W. Miller, E. Keeler Boiler Company, Williamsport, Pa. A. G. Weigel, Combustion Engineering Corporation, New York. (Two years)—F. H. Daniels, Riley Stoker Corporation, Worcester, Mass. M. E. Finck, Murray Iron Works, Burlington, Ia. A. G. Pratt, Babcock & Wilcox Company, New York. (One year)—A. W. Strong, Strong-Scott Manufacturing Company, Minneapolis. R. B. Mildon, Westinghouse Electric & Manufacturing Company, Philadelphia, Pa. R. B. Dickson, Kewanee Boiler Corporation, Kewanee, Ill. (Ex-Officio)—Owsley Brown, Springfield Boiler Company, Springfield, Ill. S. H. Barnum, The Bigelow Company, New Haven, Conn.

Office of Industrial Recovery Committee,
15 Park Row, New York

Manager—James D. Andrew.
Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President — Merle J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

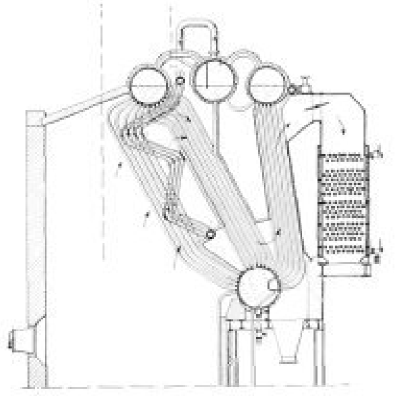
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent Attorney, 1372-1376 National Press Building, Washington, D.C. Readers wishing copies of patents or any further information regarding any patent described, should correspond directly with Mr. Galt.

1,876,291. STEAM GENERATOR. WILLIAM HUGER HARDIE, OF NEW YORK, N. Y., ASSIGNOR TO FOSTER WHEELER CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

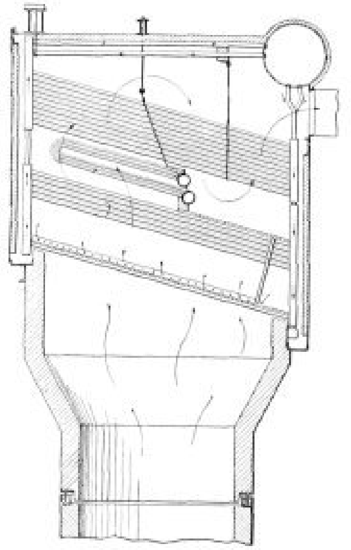
Claim.—A steam generator comprising walls enclosing a furnace chamber and a boiler space, a boiler in the boiler space comprising an upper drum,



a lower drum, a bank of vertically inclined tubes connecting the lower and upper drums and arranged to receive radiant heat, and a superheater comprising headers behind the bank and tubes connecting the headers, an intermediate support for the tubes behind the bank and said tubes having bends between the support and the headers extending forwardly toward the furnace chamber in lanes in said bank. Seven claims.

1,878,133. STEAM GENERATOR. ISAAC HARTER, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO FULLER LEHIGH COMPANY, A CORPORATION OF DELAWARE.

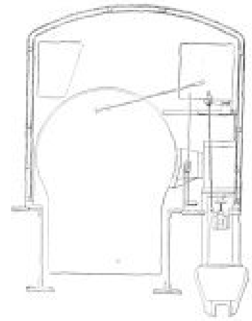
Claim.—In a steam generator, a water tube boiler having a furnace, a gas producer below said furnace and in open communication therewith, a



screen of refractory material below tubes of said boiler through which the gas from said producer passes, and means comprising air conduits to introduce combustion air into said furnace above said screen, said conduits being supported by tubes of said boiler. Three claims.

1,870,019. LOCOMOTIVE. GEORGE F. NIEGEMANN, OF HARTFORD, WASHINGTON, ASSIGNOR TO LIMA LOCOMOTIVE WORKS, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF VIRGINIA.

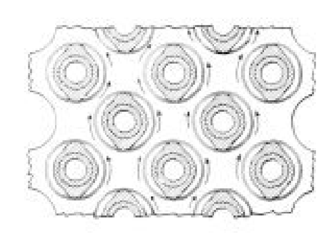
Claim.—In a locomotive having a cab, valve mechanism, and parts requiring lubrication, the combination of a lubricator located in the cab



and having feed connection to a part to be lubricated, an operating arm for the lubricator, a driving rod for the lubricator pivoted to a moving part of the valve mechanism, and a member slidable on said operating arm and pivotally connected to said driving rod, together with releasable latch means for said member. Three claims.

1,870,669. TUBE FOR BOILERS, HEAT EXCHANGERS, AND THE LIKE. ROGER STUART BROWN, OF CHICAGO, ILLINOIS.

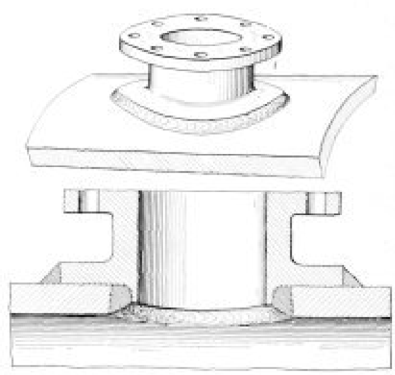
Claim.—A tube adaptable for use with heat exchangers and the like, the interior surface of which is cylindrical in cross-section, the exterior



surface of which is stream-lined in transverse cross-section, such streamlining exterior being formed separately from, and surrounding, the central cylindrical portion. For use with heat exchangers and the like, an inner tube and an outer member having its exterior stream-lined, in transverse cross-section, such exterior including a plurality of ribs lying in planes generally perpendicular to the axis of the tube. Twenty-two claims.

1,872,357. FORGED MANWAY CONSTRUCTION FOR PRESSURE VESSELS. STEPHEN STRATY, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO A. O. SMITH CORPORATION, OF MILWAUKEE, WISCONSIN, A CORPORATION OF NEW YORK.

Claim.—A forged manway for pressure vessels comprising a tubular body, a reenforcing flange at one end thereof, said flange being curved



to conform to the curvature of the vessel wall to which the manway is to be attached, a connecting flange at the other end of said body, and a thin circular lip at the inner edge of said reenforcing flange adapted to extend into an opening in the vessel wall and to provide a welding groove therewith, said tubular body, flanges, and lip being forged from a single integral billet. Three claims.

Boiler Maker and Plate Fabricator

Locomotive Orders

In locomotive production, the year 1935 was one of the worst that has occurred since 1901, but 28 steam locomotives being ordered during the year. The total for locomotives of all types amounted to but 83. This year as many steam locomotives have already been ordered as in the entire 1935 period.

During the first week of February orders for 24 locomotives were placed by two railroad subsidiaries of industrial concerns. These locomotives will cost approximately $2,300,000. In awarding contracts, the companies involved stated that the equipment is being produced for delivery as early as possible in the year to assure a supply of locomotives required for an anticipated substanital increase in traffic. Incidentally, 3000 freight cars were ordered at the same time, which will cost $10,745,000.

These orders from two railroads directly serving industrial needs may likely prove to be the forerunner of a general locomotive building program by the major roads. The need for modern motive power is becoming more pressing every day.

Welding—a Tool for Recovery

Every day that passes witnesses some new application of the fusion welding process or flame cutting process to industry. In many fields—as for example the automotive and shipbuilding—these tools are bringing about a complete revolution in design and construction.

Simplified design, decreased weight, reductions in manufacturing costs result where properly directed knowledge of these arts and skill in their application prevail. The electrical industry in applying the process to the fabrication of heavy electrical machinery, the builders of heavy machine tools, the turbine and pump manufacturers, the Diesel engine builders—all have increased the efficiency, durability and potential service of their products by the judicious application of flame cutting and welding.

Much of this work comes under the head of plate fabricating. In general, this field offers the widest possible scope for the several processes. It is not by any manner of means in the vanguard in their adoption. Restrictions against the use of fusion welding in the boiler and pressure vessel industry have gradually been lowered. Safeguards covering the procedure to be observed and the competency of welding personnel have been created. Education of the designing engineers has been extended to cover welding requirements.

Within the tremendous range of equipment produced under the category of heavy plate work there are still innumerable structures that might to advantage be fabricated by means of the welding arc and torch and by the flame cutting equipment now available.

It is the purpose of Boiler Maker and Plate Fabricator to describe as many new and unusual applications of these processes in the plate fabricating field as space will permit. Obviously we must depend for details on those directly engaged in producing such structures. Individuals in the engineering and shop staffs as well as officials of companies engaged in fabricating plate products of any character in which welding plays an important part will perform a distinct service to the industry if they will supply details of the work for publication.

Consolidate the Gains

Boiler manufacturing in 1935, according to reports of the Bureau of the Census elsewhere in this issue, took a long step on the road to real recovery—in fact a gain of nearly 25 percent over production in the previous year. From a low point in 1932, the gain last year amounted to 93 percent in the number of boilers built.

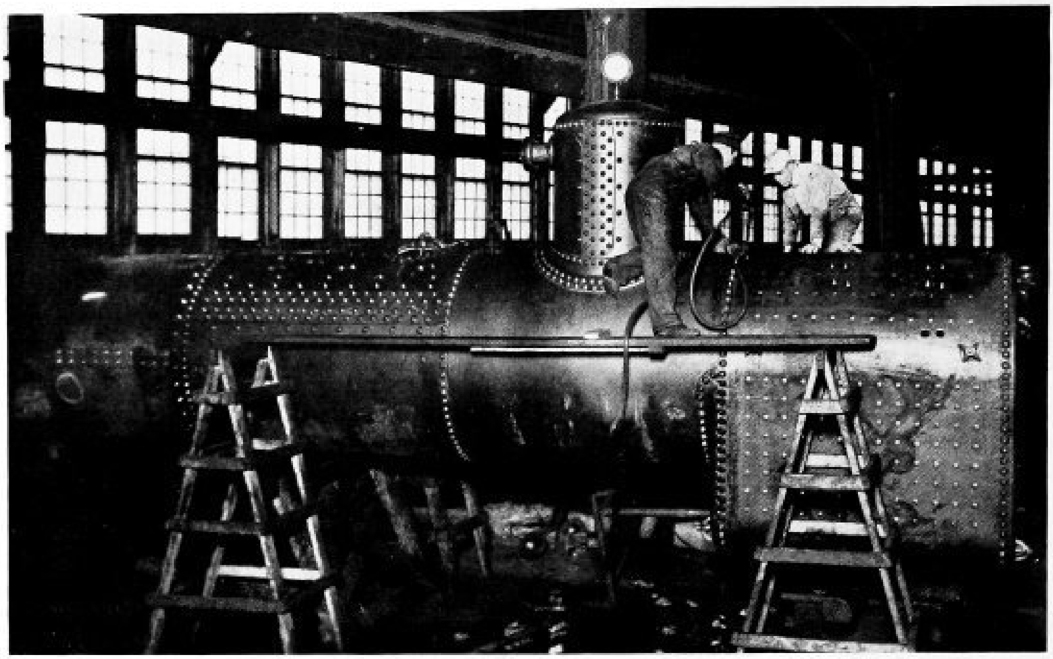
For some years now the prediction has been made that the boiler industry might be expected to improve at about the same rate as heavy industry generally. This prediction seems to be becoming a fact. Gains in the construction field, the advance in power demand, which will require utility companies to rehabilitate plants and build new ones, are factors which point to a still greater improvement in the boiler field.

In the marine industry the passage of ship subsidy legislation at this session of Congress would definitely bring about the construction of a large program of merchant vessels, practically all requiring steam generating equipment. This would be in addition to the huge naval building program now under way, which before completion will require many additional boilers of special type.

With such a record of improvement behind them since the last meeting, members of the American Boiler Manufacturers' Association and Affiliated Industries will take full advantage of the forthcoming winter meeting to consolidate the gains already made and to plan by a continuation of co-operative effort to take the fullest possible advantage of future industrial developments. Any gain in industry inevitably means that boiler equipment will be required.

Under the N.I.R.A., for the first time it was possible to organize the industry so that equable relations were maintained between member companies. It is one of the very few industries which turned this political offspring to real advantage. Also, when the Blue Eagle was torn from the industrial masthead, the boiler manufacturing industry was able on its own initiative to perpetuate many of the beneficial features of the act which had tended to produce harmony.

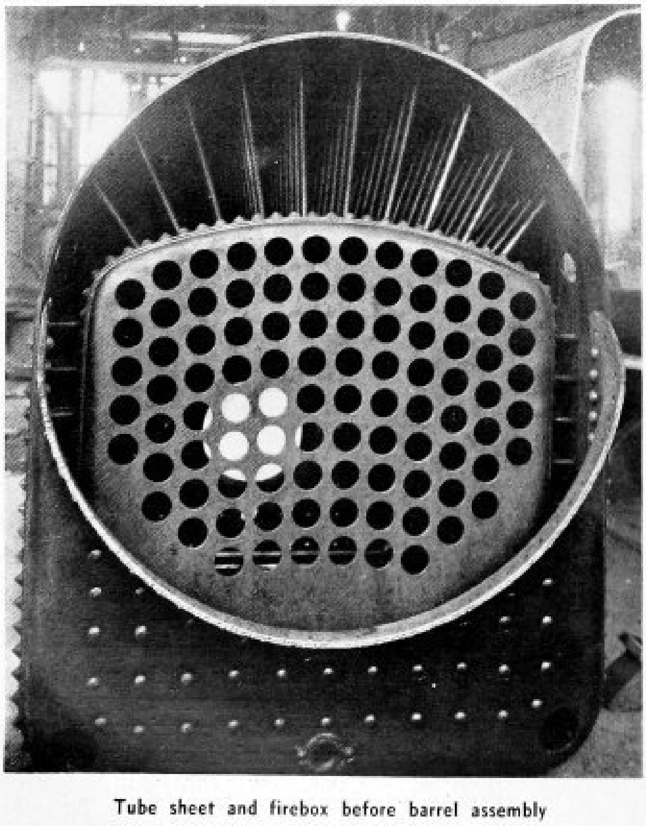
It will be disastrous if now any of this gain is lost. Within the limitations imposed on industry there is a broad field for co-operative effort. As business improves the need for a common understanding of the problems within the industry will become even greater than now exists. It is to be hoped that with the experience gained in operating the boiler manufacturing industry equitably, the harmony of the past few years will be continued to the benefit of all.



Locomotive type oil country boiler nearing completion

Arc-welded firebox features

Oil Country Boiler Improvements



Tube sheet and firebox before barrel assembly

By T. C. Ervin*

During the early part of 1934 the Lucey Boiler and Manufacturing Corporation of Chattanooga, placed upon the market an oil country boiler embodying some radical changes in design for this type of boiler.

Briefly, the changes consisted in butt welding the firebox heads to the firebox wrapper under U. S. Patents granted. By this construction, all of which conforms with the A.S.M.E. Boiler Construction Code, the section of metal between the fire and the water is of uniform thickness throughout, and the heat transfer is not retarded by lapped plates and rivet heads. Overheating, leaky seams, and burned rivet heads are avoided. The advantages of this exclusive Lucey feature cannot be overestimated and a far greater developed horsepower rating is possible with no increase in the rate of firing, than is possible with the old riveted type of construction.

For classification purposes only, the American Petroleum Institute rating of "One horsepower to each ten square feet of heating surface" is used. Nevertheless, it was thought that through basic principles in design, such as thin heat-transfer sheets, short tubes, and their arrangement, together with the new construction of the firebox, a much better development was to be expected than with boilers without these features; this at the same rate of firing.

* President of the Lucey Boiler and Manufacturing Corporation, Chattanooga, Tenn.

To ascertain whether this were true, during August and September of 1935 an actual test of a battery of the new Lucey boilers in operation under field conditions was authorized.

In the tests as conducted on the four Lucey 100-horsepower rivetless firebox boilers, each with some 1040 square feet of heating surface, 9330 cubic feet of gas was burned per hour, per boiler, with a heat value in thousands of British thermal units of 10,701. The steam produced per hour, per boiler was 6547 pounds or a ratio of 0.612 pounds of steam to each thousand British thermal units burned.

From a test of four 125-horsepower boilers, each with 1250 square feet of heating surface, conducted by the American Society of Mechanical Engineers at Oklahoma City in 1932, 6469 cubic feet of gas was burned per hour, per boiler, with a heat-value in thousands of British thermal units of 7872. The steam produced, per hour, per boiler, was 4318 pounds per boiler, or a ratio of 0.548 pound of steam to each thousand British thermal units burned.

Comparing these two tests shows that, the 100-horsepower Lucey, 84-inch rivetless firebox boiler, though having 20 percent less heating surface, nevertheless produced 11.6 percent more steam than did the 125 horsepower boiler at the same rate of firing or for each thousand British thermal units of fuel burned and under similar operating conditions.

The application of this increased capacity percent indicates that the new Lucey boiler is in reality one of 139.5 horsepower, with the very important advantage of some four to eight thousand pounds saving in weight.

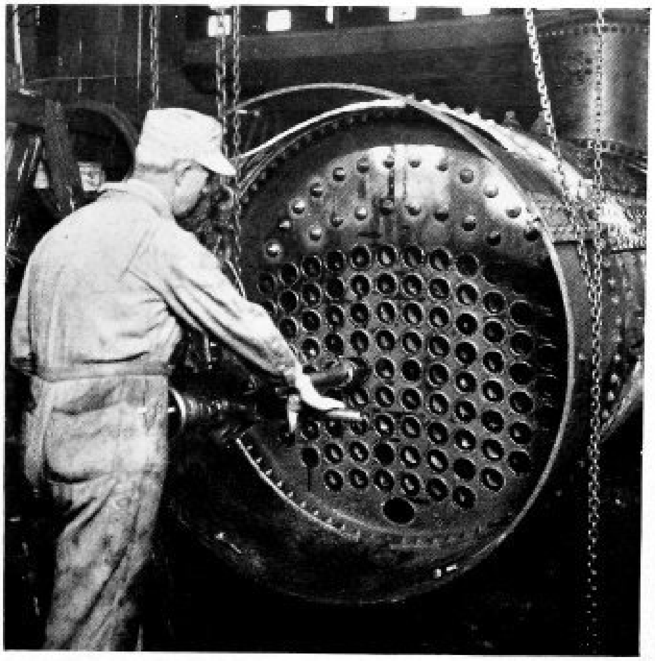
Development of the New Lucey Boiler

The outstanding improvements in the design of the new Lucey 84-inch rivetless firebox oil country boiler may be stated as follows:

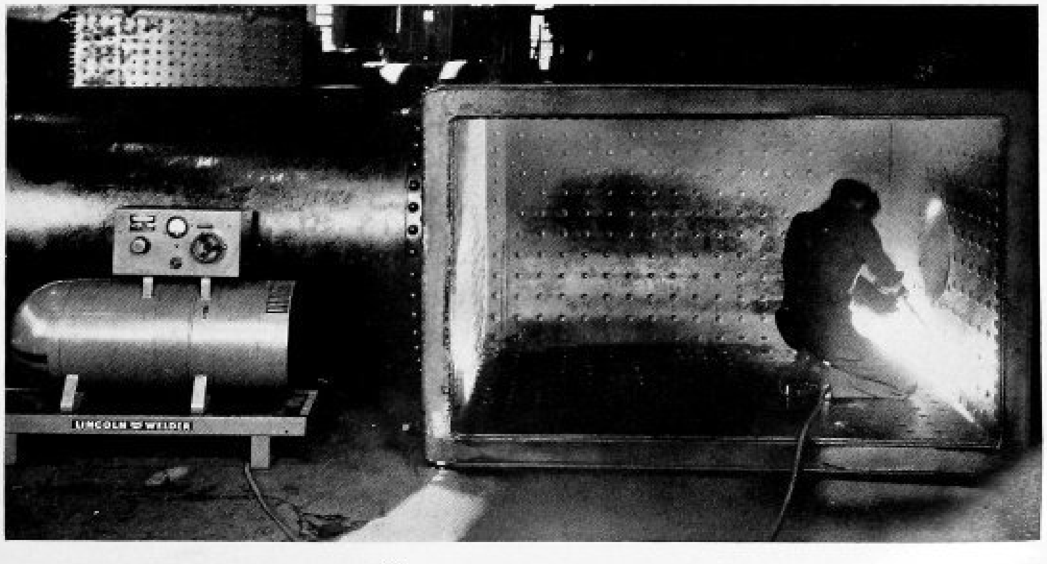
Fire Door Opening. The fire door opening is formed by flanging the back head inwardly, and the firebox door head outwardly, then butt welding the joint with a welding rod of superior quality. This construction is specifically advised by the A.S.M.E. Code and insures close proximity of the water to the fire, keeping the sheets cool and lessening the liability of burned plates.

Fire Box. The removal of all rivets and seams from the firebox. Since the art of welding has advanced so rapidly and the A.S.M.E. Code permits welding "Where the safety of the structure is carried by other construction." This elimination was accomplished and patented, by butt welding the firebox wrapper to the firebox door and tube heads after they have been flanged as usual, except that now, these heads have a much deeper flange, enabling the weld to be made between two adjacent rows of staybolts. This weld is carefully done from the fire side first, where the metal has been chipped to permit an angle of some 70 degrees for the weld. Each bead of welding laid therein is thoroughly cleaned before the next layer is put on. After finishing this side, the other side is machined out well into the metal of the sheets and into the first weld, and the whole again carefully built up by welding as before. The firebox then is of uniform thickness throughout and heat transfer is even and not retarded by lapped seams or rivet heads. Overheating, leaks, and burned rivets are avoided.

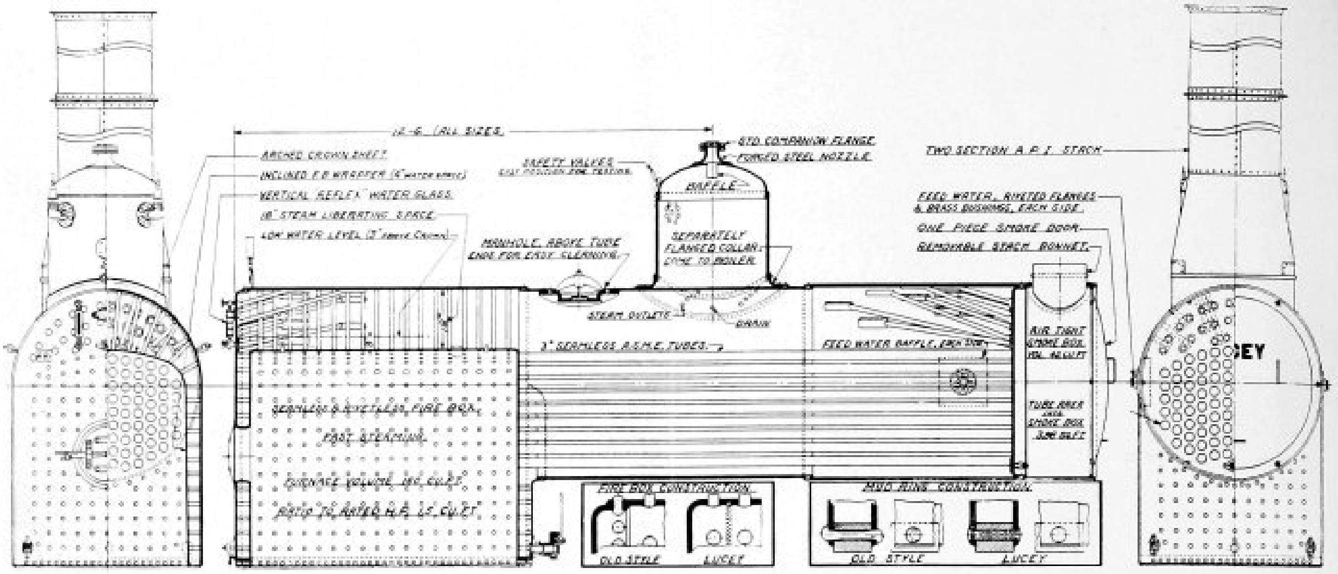
With 84 inches as the length of the firebox, the furnace volume is increased giving a ratio of some 1½ cubic feet to each 10 square feet of heating surface, a



Rolling tubes into sheet



Welding firebox of an 84-inch boiler with the shielded-arc process of electric welding



Sections through Lucey welded firebox oil country boiler, showing details of construction

much larger ratio than formerly. A much better generation of steam is possible; for it is a well-known fact that fully 60 percent of the steam is generated around the firebox in this type of boiler.

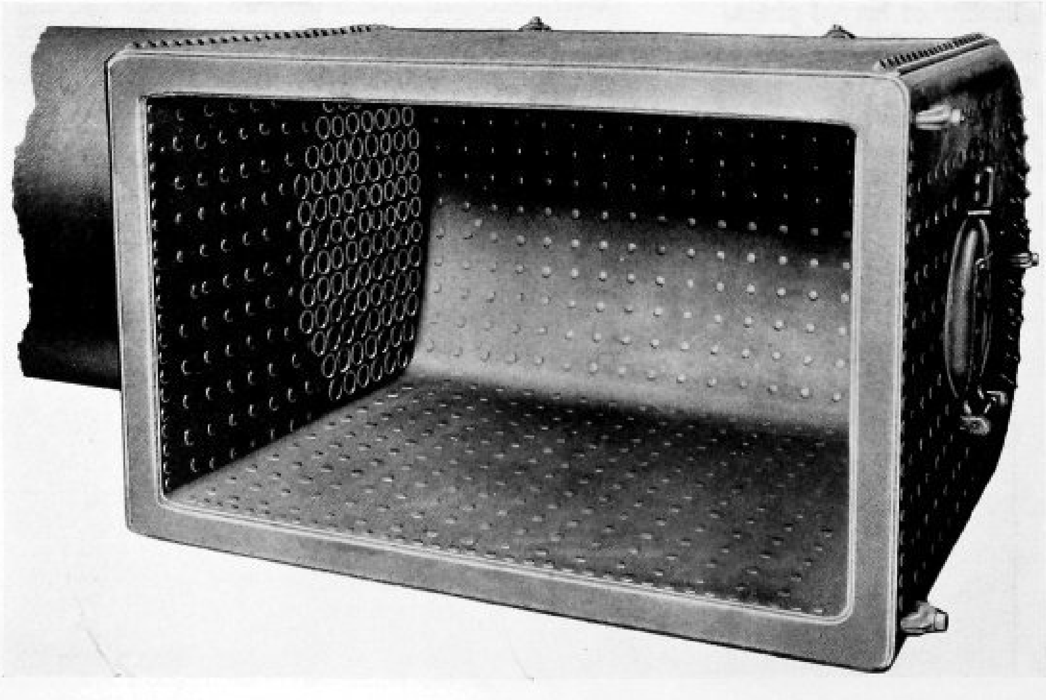
Crown Sheet. By arching the crown sheet and making the lateral corner radii as large as possible, a surface is provided in the firebox that permits greater transfer of heat as well as providing better combustion. This curving of the firebox wrapper in the same direction as the outside wagon top permits more and better threads for the radial bolts and the top of the crown sheet is more readily cleaned.

The side sheets of the firebox are sloped inwardly at the top, making the water space wider there than at the mud ring; this increased the circulation of the water which is highly important.

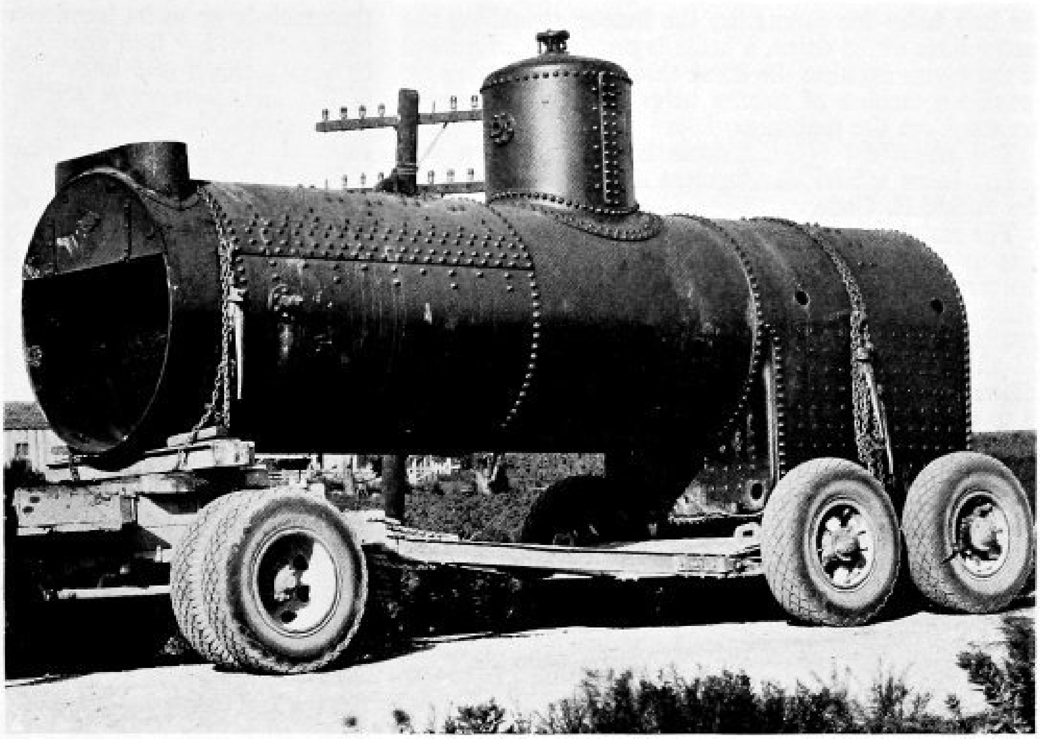
Above the crown sheet, between its top and the inside of the wagon top wrapper, an adequate steam liberating space of at least 18 inches is provided. This space permits the steam to leave the water without carrying it over and enables a greater volume of water to be carried in the boiler.

On the outside of the back head, two lugs are welded thereto clearly showing the height of the crown sheet and by resting a level upon them, the boiler can be readily leveled up at the firing end.

Mud Ring. Carrying out the basic idea of keeping the water always as close to the heat as possible, the mud ring is fastened to the boiler with screwed staybolts. The sheets are drilled ¼ inch under size and when lined up to the mud ring, reamed and tapped out for the staybolts, which are then screwed into place and the ends riveted over. The inside of the firebox then presents a smooth surface easily kept cool, and troublesome rivet heads are done away with. Not only the rivet heads



Completely welded firebox of the Lucey boiler, which is characterized by the absence of rivets and seams



Modern transport makes easy the movement of oil country boilers from one location to the next

but the impracticability of driving properly the extremely long rivets is removed.

Since this type of boiler cannot practically be given as much care as is desirable, and when it is remembered that it is merely a means to an end, i.e., of "making hole," it seemed advisable to take every precaution to forestall costly delays. With this in mind, every seam under the firebox at the mud ring that cannot be readily gotten to for re-calking, is welded for tightness and heavily so at the corners. It is impossible to express the pleasure the operator finds with this type of firebox that will never leak and that does not show so much as a sweat of water on test.

Stayed Surfaces. A large part of the time required for the design, manufacture and cost of this type of boiler is due to the necessity of staybolting. The old V form thread has been replaced by the better and strong U. S. form thread. All staybolts 8 inches and under in length must be drilled to a depth of ½ inch beyond the inside sheet at the outer end, with a tell-tale hole. This allows the steam to escape should a bolt crack, and serves as a warning to replace it before serious injury has occurred to the boiler. Diagonal braces are used on the flat unstayed portions of the back head and as well as on the front tube head.

The maximum size of the staybolts used is definitely fixed by the A.S.M.E. Code for various plate thicknesses and by limiting the stress to 7500 pounds per square inch. There is no advantage gained by making them larger than required as this allowable stress provides a factor of safety of from 6 to 7. There is considerable movement of the firebox as a whole which accounts for the greater part of the staybolt breakage. Using a larger diameter staybolt in order to cut down on the required number is of no advantage since the larger the bolt the greater the rigidity and more likely early failure. Greater flexibility is possible with the smaller bolt.

Tubes. A.S.M.E. seamless, open-hearth tubes of 3 inches outside diameter are used and installed in vertical rows. This layout permits easy cleaning. We hold consistently to short tubes, 13 feet, since tests have proven the temperature drops considerably beyond this length. We believe short tubes are better since the heat-transfer is questionable and certainly the circulation is extremely poor. Sagging of long tubes has been observed also.

The firebox ends of all tubes are welded, care being taken to apply as light a bead as practical in order not to have an excess of metal that might burn. All welding on these boilers is done with electrodes and equipment of the Lincoln Electric Company, Cleveland.

Domes. The location of the dome on this type of boiler has always been a subject of a great deal of discussion. Whether it was better to put it over the firebox of the boiler or over the barrel was the question. In the early days its function was probably of greater importance than it is today; then it possibly did act as a storage place for steam. Today, however, it is doubtful whether the steam stays there long enough to claim this point. We believe that, other than a possible place for catching some of the moisture in the steam, its value is questionable.

We think the preferable location to be over the barrel of the boiler and the dome is so located on all Lucey boilers at a standard distance from the face of the back head on all boilers whatever their working pressure or horsepower. This location gives the steam that comes from over the firebox and, which is in its wettest state, a better chance to dry out or lose some of that moisture before entering the dome. Some advocate locating it well over the front course near the stack, but located there it would interfere with the diagonal braces.

With a standard 84-inch firebox for all manufacturers it would be of value to the users to have all makes of boilers adopt a standard distance from the face of the back head to the center of the dome. This would make their pipe hook-ups interchangeable.

The intention being to make the dome function as a trap for moisture, as far as possible directly beneath the steam outlet nozzle, which is lined upon the boiler with the bolt holes for connecting the header straddling the center lines of the dome, a baffle is provided and instead of the steam entering the dome through one opening we provide a number of smaller holes in an effort toward breaking out the moisture.

The ellipsoidal type of dome head is used on this boiler, being a later development and recommended by the A.S.M.E. Code.

The early method of fastening the dome to the boiler was to flange the dome shell itself. In doing this the danger was that the metal thinned out at the knuckle and when so flanged a certain amount of laying up was necessary to line up the rivet holes. Sledging was about all that could be used to accomplish this and is not allowed by the code. A far better type of construction is to use a separately flanged collar, fitted to the boiler and riveted to the dome shell. This acts as a stiffener against the expansions and contractions of the boiler as it fluctuates in pressure and is far less liable to leaks. Lucey employs this type of construction.

Rivets. Open hearth steel rivets, with a shearing strength of 44,000 pounds per square inch of cross sectional area are used. These are hot drawn and properly annealed. Wherever it is possible all rivets are hydraulically driven, and care is taken to hold the pressure on them until each rivet has cooled enough so that any further contraction will not take place and cause it to leak. No rivet so driven should require calking. Of all rivets in this boiler 95 percent are driven as indicated above.

Joints. All longitudinal joints are of butt and double strap construction. The straps should be given the exact curvature of the shell through pressing each strap hydraulically on dies of the right radius; this, as well as the ends of the barrel sheets. This insures perfectly cylindrical barrels that do not hinge at the strap rivets, under fluctuations of the pressure that the boiler goes through. This hinging action readily causes leaks and eventually cracks. Straps should be first bolted in place, holes reamed to size, then the straps removed and all reamings and burrs taken out, to insure a metal-to-metal fit and prevent the rivet, when driven, from forming a collar between the straps and the shell.

In connecting the firebox complete to the middle course at the wagon top and throat sheet, it has been found better practice to run the wagon top girth seam straight down the water leg and curve the throat sheet into it just below the center line. The upper half or the thicker middle course is extended backward to connect with the wagon top.

Smoke Box. The smoke box is closed with a dished smoke door. This door is in one piece with suitable handles and fits snugly into the barrel of the boiler. No protruding or loose fastenings are used that might be bent, broken off, or lost in moving. An air tight smoke box is of material advantage.

Stack Bonnet. The stack bonnet is welded at the ends presenting a smooth fit to the stack. It is flanged outwardly to connect to the boiler with ample bolts to insure tightness. The fact that it can be removed to avoid damage when moving can be appreciated. Material used is 10 gage blue annealed steel and all dimensions are to the A.P.I. standards.

Stacks are 12 gage blue annealed steel and are constructed to the A.P.I. standards. They are in two sections, connected together by two angle iron rings, with a third ring at the top of the upper half to enable an extra section to be added if desired.

Formerly about the only thought that was given to the manhole or to its location was that it was simply a means of getting into the boiler and its location could be anywhere. In our latest design it will be found back of the dome between it and the back head, as close as possible over the firebox tube head, where washing and removal of scale is most difficult.

Ten 3½-inch by 4½-inch A.P.I. standard manholes are provided; four (two in back head, and two in throat sheet) just above the mud ring; one in back head on level with crown sheet; one in the front tube head below the tubes. Forged steel plates and crowfeet are best.

In order to secure perfect threads and straight tapped openings, pop safety valve and feed water openings are equipped with pressed steel flanges, riveted and calked to the boiler.

The two pop safety valve flanges are located, one each, at 45 degrees from the longitudinal center line of the boiler, on the back head side of the dome, in easy position for the fireman to release the pops occasionally.

Two feed-water connections are provided, one on each side of the boiler. Each is equipped with a baffle on the inside to prevent cold water from immediately coming in contact with the tubes.

The blow-off connection is also a 2-inch threaded flange with a shoulder on the water side and is welded in the lower center of the throat sheet.

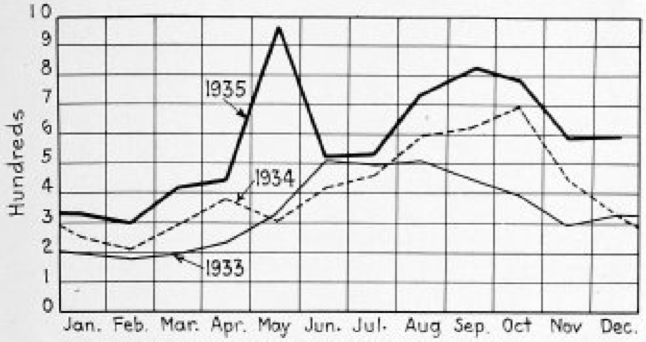
The flanges are tapped to 2-inch pipe size and brass bushings are furnished to reduce to the required size. Where nipples are broken off at this point, or the fitting is badly corroded, the brass bushing can be easily removed without injury to the threads.

Fittings and pipe nipples are extra heavy and in accordance with the American Petroleum Institute standards. Steam gages are graduated to 500 pounds, or at least 1½ times the working pressure.

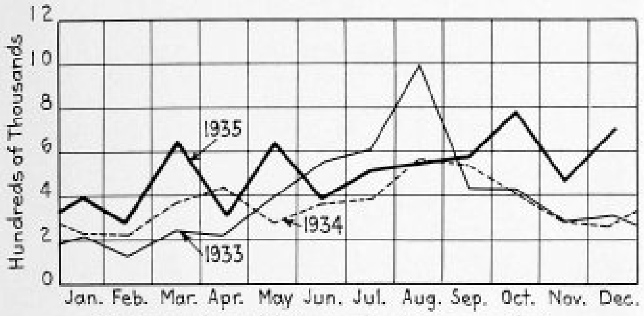
Inspection. There is only one positive way to manufacture a boiler to the A.S.M.E. Boiler Code, and that is by maintaining a constant close inspection during its construction. A licensed boiler inspector, not connected with the shop personnel, who maintains a rigid inspection of every part of the boiler, is in the shop every working day. This man is thoroughly familiar with the code, and though the cost is greater, the A.S.M.E. Code stamp on the boiler is the guarantee, and the certificate of inspection is the proof, that the boiler has met every requirement of the code. Each boiler is put through a hydrostatic test 50 percent in excess of its allowable working pressure, and while under pressure must be absolutely free from leaks.

In concluding, it is my opinion that the firetube type of boiler for oil country service is more or less impracticable and approaches a dangerous state when made to operate above 250 to 300 pounds per square inch pressure. It might be better to give more attention to the protection or insulation of the boilers to avoid temperature and pressure drops and be found cheaper. The cost of maintenance of high-pressure boilers is high and larger steam cylinders or a rearrangement of steam pumps might be cheaper. Few pieces of drilling equipment are designed for pressures in excess of 250 pounds. Boilers of greater pressures than 300 pounds bring vastly increased weights that make their movement over highways a serious handicap. Finally, the real solution is not more pressure, but a proper conservation and use of what is already available.

Stainless Steel.—An interesting and attractive booklet, which presents in colors, applications of Allegheny stainless steel in many lines of industry, has been issued by Joseph T. Ryerson & Son, Inc., Chicago.



Trends of new boiler orders, 1933-1935



Heating surface of boilers ordered in square feet

Boiler and Plate Industries Improve

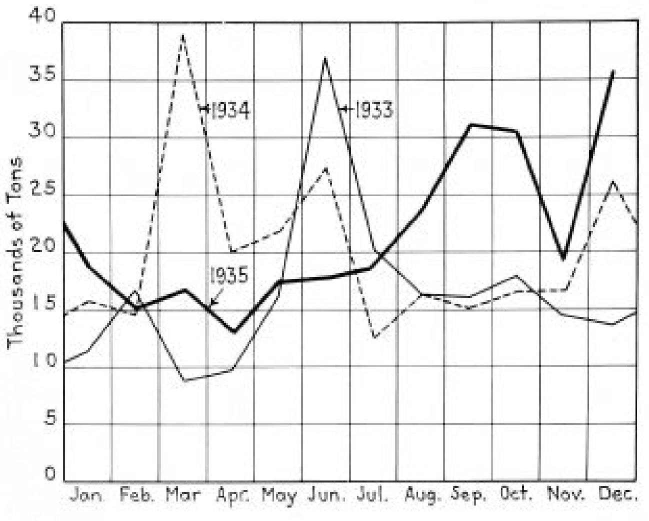
According to reports of the Bureau of the Census, Department of Commerce, the past year has seen a substantial gain toward full recovery in the boiler manufacturing and heavy plate fabricating fields. The boiler manufacturers have increased production to a point that compares favorably to 1931, while the associated equipment group, such as manufacturers of pulverizers and mechanical stokers, show remarkable gains. The steel plate fabricators report lesser degrees of increased production but still of an encouraging order, and the year closed with a strong upward trend in the entire field.

During the past year 7040 boiler units were ordered

Orders for Steel Boilers—1930 to 1935

Item	December 1935	December 1934	Total (Year) 1935	Total (Year) 1934	Total (Year) 1933	Total (Year) 1932	Total (Year) 1931	Total (Year) 1930
GRAND TOTAL:								
Number	595	331	7,040	5,009	4,118	3,652	7,673	12,758
Square feet	684,735	259,875	6,245,158	4,368,563	4,818,362	3,501,107	6,827,364	12,996,007
STATIONARY:								
Total:								
Number	575	321	6,883	4,841	3,920	3,580	7,508	12,501
Square feet	580,552	235,065	5,821,773	4,005,792	4,063,818	3,377,567	6,327,262	11,862,594
Watertube—								
Number	57	28	653	478	551	382	672	1,070
Square feet	265,701	108,829	2,914,401	1,951,020	2,361,557	1,797,591	2,838,608	5,562,877
Horizontal return tubular—								
Number	35	22	368	374	393	259	487	879
Square feet	54,064	20,074	464,565	485,530	510,356	326,770	612,802	1,179,486
Refractory-lined firebox return tubular—								
Number	19	(*)	140	(*)	(*)	(*)	(*)	(*)
Square feet	19,607	(*)	128,884	(*)	(*)	(*)	(*)	(*)
Locomotive (not railway)—								
Number	14	3	69	39	59	53	103	167
Square feet	11,308	2,165	46,014	28,920	35,371	45,153	87,030	145,251
Steel heating (as differentiated from power boilers)—								
Number	369	218	4,753	3,207	2,292	2,317	5,201	8,081
Square feet	183,076	79,323	1,870,681	1,169,277	851,071	964,131	2,300,394	3,546,144
Scotch type—								
Number	12	(*)	101	(*)	(*)	(*)	(*)	(*)
Square feet	5,692	(*)	43,324	(*)	(*)	(*)	(*)	(*)
Self-contained portable—								
Number	11	22	153	255	200	166	302	438
Square feet	7,018	15,523	106,313	180,504	152,481	120,803	233,888	310,027
Vertical fire-tube—								
Number	37	23	498	393	360	373	626	1,140
Square feet	10,516	4,617	121,945	105,088	88,625	102,016	173,106	340,470
Oil country—								
Number	21	4	119	63	41	7	52	586
Square feet	23,570	3,930	113,225	58,547	37,862	5,612	48,430	661,207
Miscellaneous—								
Number	...	1	29	32	24	23	65	140
Square feet	...	604	12,421	26,906	26,495	15,491	33,004	117,132
MARINE: †								
Total:								
Number	20	10	157	168	198	72	165	257
Square feet	104,183	24,810	423,385	362,771	754,544	123,540	500,102	1,133,407
Watertube—								
Number	17	3	103	72	132	20	88	172
Square feet	103,290	23,237	396,834	313,381	713,141	84,099	455,987	1,072,103
Pipe—								
Number	...	...	5	7	2	6	7	3
Square feet	...	...	5,483	7,292	2,360	11,076	8,159	3,217
Scotch—								
Number	3	7	49	81	63	44	60	75
Square feet	893	1,573	21,068	33,906	37,943	22,891	26,286	54,159
Miscellaneous—								
Number	...	...	...	8	1	2	10	7
Square feet	...	...	...	8,192	1,100	5,474	9,670	3,928

* Data not available.
† No boilers of the 2 and 3 flue type have been reported during the period 1930 to 1935.



Orders for fabricated steel plate products

with a total heating surface of 6,245,158 square feet, as against 5009 units of 4,368,563 square feet heating surface during the previous year, a gain of 24.7 percent in number and 23.3 percent in heating surface area. A comparison of the record for several years back also indicates that the production in 1935 in the boiler manufacturing industry was 93 percent greater in number of units ordered and 78 percent more in heating surface area than the depression's low of 1932. Recovery has progressed to a point where the industry now stands at 92 percent of the 1931 production level. However, a long road still lies ahead before full recovery is reached, because the past year's business reports only 55 percent of the number of boilers produced in 1930 and 48 percent of the total heating surface built in that year. An accompanying chart shows the past year's orders as compared with 1933 and 1934.

Fabricated Steel Plate Orders—1933 to 1935

New Orders (Tons)

Year and Month	Total	Oil Storage Tanks	Refinery Materials and Equipment	Tank Cars	Gas Holders	Blast Furnaces	Miscellaneous
1935							
January	18,778	1,389	1,202	335	167	375	15,310
February	15,064	2,531	1,156	62	503	256	10,556
March	16,832	2,377	965	72	456	15	12,947
April	13,244	2,152	877	121	399	150	9,545
May	17,630	3,690	821	54	347	48	12,670
June	17,914	1,872	1,994	278	1,030	15	12,725
July	18,890	4,193	1,615	10	573	25	12,474
August	23,628	3,505	2,599	709	531	60	16,224
September	31,105	3,531	3,061	162	74	83	24,194
October	30,530	5,850	3,081	222	334	70	20,973
November	19,116	2,617	2,620	126	8	50	13,695
December	35,584	9,341	5,327	625	173	99	20,019
Total (Year)	258,315	43,048	25,318	2,776	4,595	1,246	181,332
1934							
January	15,897	3,754	480	271	880	...	10,512
February	14,641	2,476	1,337	55	216	105	10,452
March	38,924	2,202	2,495	356	65	...	33,806
April	20,085	2,998	2,338	128	1,174	...	13,447
May	21,891	8,746	1,767	131	445	...	10,802
June	27,395	11,019	1,359	913	382	80	13,642
July	12,523	2,028	946	146	737	765	7,901
August	16,293	3,334	1,452	47	548	57	10,855
September	15,108	3,445	2,305	819	62	259	8,218
October	16,581	927	2,280	328	158	331	12,557
November	16,629	3,252	2,673	164	263	25	10,252
December	26,025	5,185	2,710	603	1,609	600	15,318
Total (Year)	241,992	49,366	22,142	3,961	6,539	2,222	157,762
1933							
January	11,448	1,718	521	73	203	...	8,933
February	16,706	8,347	255	...	291	35	7,778
March	8,896	1,270	320	...	282	3	7,021
April	9,719	2,983	347	73	25	...	6,291
May	16,243	2,858	1,045	...	4,157	...	8,183
June	37,020	20,894	1,646	333	36	98	14,013
July	20,391	6,013	1,884	301	651	125	11,417
August	16,320	2,581	2,086	1,030	...	5	10,618
September	16,166	1,033	1,084	34	127	145	13,743
October	17,964	1,434	331	207	3,705	...	12,287
November	14,466	3,734	978	225	48	15	9,466
December	13,692	2,160	717	124	872	...	9,819
Total (Year)	199,031	55,025	11,214	2,400	10,397	426	119,569

Steel Plate Fabrication

The steel plate fabricating industry did not enjoy quite so encouraging a year but gains were made, nevertheless. Reference to the charts for the twelve months past will show a definite upward trend in number of orders, particularly so in the latter half, so that the outlook for 1936 looks fairly bright. New orders for fabricated steel plate in 1935 totaled 258,315 tons as compared with 241,992 tons for the year previous, a gain of 3.8 percent. More recovery has been made in this field than the above figures may indicate, for comparison with the orders placed in 1933 shows a gain of 29.7 percent over that year. Examination of the reports indicates that although the orders for oil storage tanks, tank cars, gas holders and blast furnaces all showed a decline from 1934, the gains in orders for refining material and equipment and miscellaneous items were sufficient to offset these losses and still produce a small increase.

The production of steel barrels in 1935 showed a small increase over the production of 1934; 6,876,650 barrels being produced as compared with 6,679,322 barrels the previous year, an increase of 3 percent. Conditions have been quite static in this phase of the steel industry in the last three years as the percentage increase in production over 1933 is found to be but 4.6 percent.

In the field of equipment allied to boiler manufacturing, surprising gains were made in the number of installations of mechanical stokers when a comparison of reports shows that 41,726 units were installed in 1935, a gain of 67 percent over 1934. Most of these installations, however, were of the residential low-powered type. New orders for pulverizers were also very encouraging, with a 76 percent gain in number of units ordered and a 97.5 percent gain in total capacity in pounds of coal.

Electrode for Stainless Steels

A new arc-welding electrode for welding the group of stainless steels belonging to the 25-12 variety has been announced by research engineers of The Lincoln Electric Company, Cleveland. Because of its higher chrome content the new electrode is particularly advantageous for welding stainless clad steels.

This electrode, known as Stainweld B, provides weld metal of the same characteristics as steel containing 25 percent chromium and 12 percent nickel. The weld metal provided by the electrode has the high corrosion-resistance, high tensile strength and ductility possessed by the 25-12 alloy steels.

Stainweld B electrode is heavily coated, utilizing the shielded arc principle of producing welds free from oxides and nitrides, brittleness and porosity. The high quality of the weld metal produced is shown in results of tensile strength and accelerated corrosion tests. Tensile strength tests show that Stainweld B weld metal resists a stress of 95,000 pounds per square inch. Test coupons broke under this stress after the area of the weld metal had been reduced to make the failure come in the weld.

In addition to possessing high tensile strength and unusual resistance to corrosion, Stainweld B weld metal has high ductility and is exceptionally resistant to abrasion. Moreover, it is claimed the deposit maintains these physical properties at high temperatures. Scaling is reduced to a minimum for this type of material.

This electrode, together with the well-known Lincoln Stainweld A for 18-8 stainless steels, now makes it possible to arc weld practically any of the more extensively used stainless alloys. Stainweld B is available in $\frac{5}{32}$ and $\frac{3}{16}$-inch sizes in 11-inch lengths. It comes packed in 15-pound containers in the $\frac{5}{32}$-inch size and 10-pound containers for the $\frac{3}{16}$-inch size.

Britain's First Super-Pressure Boilers

By G. P. Blackall

Special interest attaches to the fact that the North Metropolitan Electric Supply Company, London, has ordered two large Loeffler boilers for installation in its Brimsdown power station. These boilers, which will operate at pressures up to 2000 pounds per square inch with 940 degrees F. superheated steam temperature, will be the first of the various new advanced super-pressure designs of steam boiler to be employed in the United Kingdom under commercial conditions. Incidentally, a 1200-pound pressure Babcock and Wilcox boiler is in operation at Bradford, but this is of the ordinary forged drum type.

The boilers ordered for the Brimsdown station are each of 210,000 pounds per hour evaporation, and operate in conjunction with a 20,000-kilowatt super-pressure back-pressure turbine which exhausts at 160 pounds, the steam being reheated to 820 degrees F., and used to drive a 30,000-kilowatt condensing turbine. The general principle of these boilers is to blow highly superheated steam into water, the heat from the combustion chamber being transmitted to the steam in steel coils and not to the water in drums and boiler tubes.

British Report on Marine Boiler Explosion

The findings of a court of inquiry appointed by the British Board of Trade to investigate the circumstances of a boiler explosion in the steamer *Constance*, of Leith, have just been delivered by the presiding commissioner, Sir Dawson Miller, K. C.

The explosion occurred last August off Flamborough Head, when the vessel was on a voyage from Leith to Boston, and resulted in the death of the second engineer.

The court found that the immediate cause was the wasted condition of the starboard combustion chamber bottom plate of the boiler. The boiler was constructed in 1902 and angle bar stiffeners were fitted to the underside of each furnace. In 1927 the angle bar stiffeners were removed in order to effect repairs and were not replaced. In the opinion of the court their removal lessened the strength of that part of the boiler.

The court considered that the owners were in part to blame for the accident, because they neglected to carry out the obligations imposed upon them by the Merchant Shipping Act to report to the Board of Trade some damage to the boiler discovered in July, 1935. The court was convinced that, if that damage had been reported, the Board of Trade would have sent a competent engineer surveyor to examine the boiler and the result would have been that the boiler would have been made safe to the persons working near it. The court expressed the view that it should not be left to the discretion of the shipowner to determine whether the damage was serious enough to be reported.

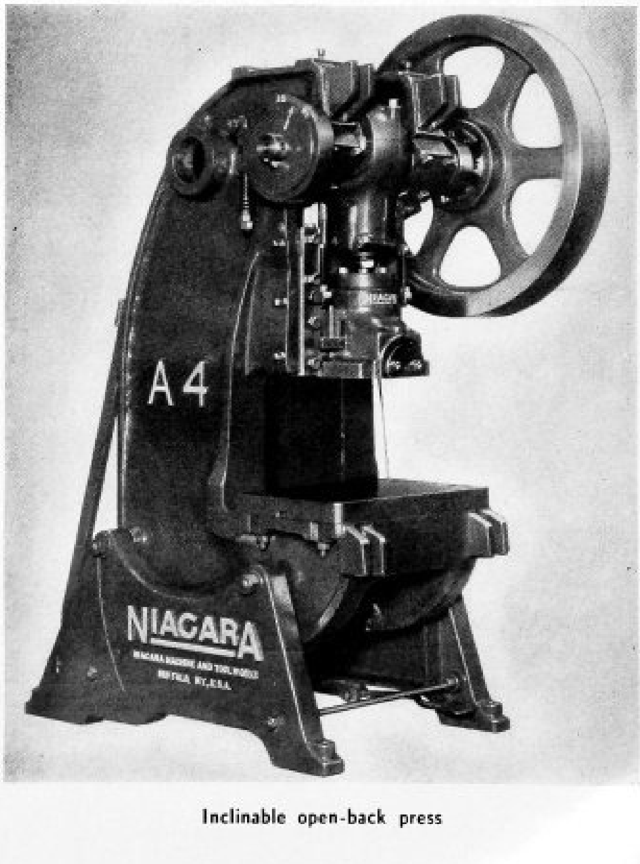
The court ordered the owners to pay £100 towards the cost of the inquiry. The superintendent engineer of the owners was found not guilty of any wilful neglect of duty, but he had failed to appreciate the consequences which might ensue from his action in failing to replace the angle bar stiffeners. He was ordered to pay £10 towards the cost of the inquiry.

The court considered the owners' assistant superintendent engineer was seriously at fault for assuming that the wastage of the boiler plates was only confined to a small place, whereas it was general. He was likewise ordered to pay £10 towards the cost of the investigation.

Niagara Open-Back Press

The Niagara Machine and Tool Works, Buffalo, has announced the addition of a new Master Series No. A-4 press to its line of inclinable open-back presses. This press has a 4-inch diameter forged and ground main shaft. The frame is scientifically designed for strength and rigidity both as to its design principles and placement of metal, as well as analysis of materials.

The No. A-4 press follows the same general design as the other sizes in the Master Series line and includes the quick-acting, six-point engagement clutch, new type slide with breech-block die clamp and equal support for the die from center to front and center to rear, double "V" gibs, motor drive on top, self contained anti-friction back gear, compensating brake, and one-man inclining device equipped with anti-friction bearings.



Inclinable open-back press

Methods developed for

CONTROLLING SUPERHEAT*

By Thomas B. Stillman†

The fundamental reason for controlling superheat is to provide steam temperatures at the turbines which are most suitable for their efficient operation over a relatively wide range of rating of the boilers. Another reason of almost equal importance in modern high temperature installations on shipboard is to insure proper steam temperatures under maneuvering conditions, so that possible damage to the propelling machinery and condensers will not occur. Also, in a marine installation, the steam requirements in port are radically different from those under way, requiring control of the superheat to meet these special conditions properly.

Aside from the effect change of boiler rating has upon superheat, there are a number of other factors in connection with boiler and furnace operation that affect superheat.

Increasing the feed-water temperature to a boiler decreases the superheat for a given rating. This is because an increase in feed-water temperature increases the steam flow through a superheater, with no corresponding change in the gas flow over the superheater.

A number of the auxiliaries as well as the heating load usually require saturated steam. If this steam is taken directly from the boiler drum, the steam so taken by-passes the superheater, and the remaining steam absorbs more heat per pound than if all the steam generated by the boiler went through the superheater.

It is because of this radical effect that by-passing of steam has upon the temperature of the remaining steam coming from the superheater under maneuvering conditions that desuperheaters for auxiliary steam have come into quite general use aboard modern steamships. In this way, all of the steam generated by the boiler is allowed to pass through the superheater at all times, the auxiliary steam then being desuperheated as required.

The percentage of boiler surface between the superheater and furnace is an important factor in the slope of a superheat-rating curve. A convection-type superheater well removed from the furnace will show a rapid percentage increase in superheat with rating. As the superheater is moved nearer the furnace the superheat-rating curve tends to flatten, and it is possible to locate a superheater so that it will have a flat superheat curve over a wide range of rating. A radiant-type superheater located in the furnace walls will give decreasing superheat with increase in rating. By combining a radiant-type superheater with a convection-type in the same boiler, a comparatively flat superheat curve may be obtained.

With our present knowledge of metals, the commercially feasible procedure aboard ship is to have the superheater so located in the boiler that a rising superheat with rating characteristic will be obtained.

From the preceding it will be realized that, as higher steam temperatures are employed and less margin is left for the designer to work to, some form of superheat control becomes essential, not only to assure a relatively flat superheat-rating curve, but also to take care of the possible variations in superheat that may occur due to the operator's procedure in handling the boilers.

Fundamentally, there are two principles generally employed for controlling superheat: (1) Providing an excess of superheating surface so as to give the desired steam temperature at low rates, with provision for cooling the steam at the higher rates, and (2) controlling the flow of gases over the superheater so that the steam temperature always remains within certain limits regardless of the rating of the boiler.

The cooling type of control may be divided into (a) those injecting water into the steam and (b) those cooling the steam in a heat exchanger by conducting the excess heat to the feed water or the boiler circuit: (a) may again be divided into (1) spray-type desuperheaters and (2) those employing surface evaporation, where water is allowed to trickle over wires or metal surfaces exposed to the superheated steam, the water being evaporated and picked up by the steam as it flows past.

The spray-type desuperheaters are relatively simple and compact, but to obtain consistently satisfactory results with them the water should be finely atomized and a reasonable length of travel allowed the steam beyond the spray before its utilization in a turbine to insure complete evaporation of the water and thorough mixing of the steam. Suitable automatic thermal control should be provided to govern the amount of spray water, the thermal element being located some distance down the pipe to assure properly mixed steam for actuating the control.

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* Abstract of paper presented at forty-third annual meeting of The Society of Naval Architects and Marine Engineers, New York.

† Engineering department, The Babcock & Wilcox Company, New York.

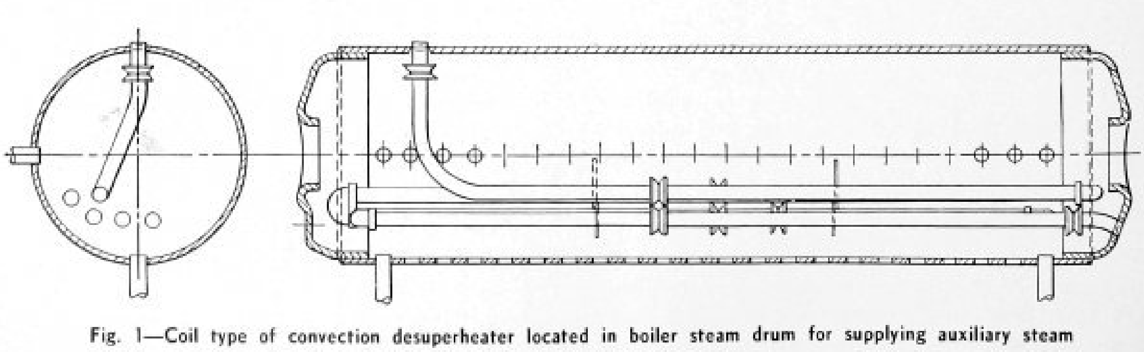


Fig. 1—Coil type of convection desuperheater located in boiler steam drum for supplying auxiliary steam

With spray-type desuperheaters it is also essential that the spray water used be of exceptional purity, if difficulty is to be avoided further along in the circuit with impurities in the steam.

The surface evaporation type of desuperheater largely eliminates the carry-over of solids from the water to the steam, the majority of these being left on the wires, but the control picture from the point of view of momentary water carry-over or excessive steam temperature under conditions of varying steam flow, is similar in both types.

The convection type of desuperheater eliminates the possibility of contamination of the steam with impurities from the cooling water, as the two are never allowed to mix. As previously indicated, either feed water or water from the boiler may be used for the cooling medium. Feed water permits the use of a smaller unit due to the better thermal head available, but the boiler water installation is the simpler from an operating point of view and will not cause fluctuations in the feed-water temperature as it enters the boiler.

Fig. 2 illustrates the construction and principle of operation of one of these units. The thermally actuated butterfly valve in the steam line serves to control the percentage of steam diverted to flow through the cooling tubes, which are surrounded with water. By varying the percentage of steam so diverted, any desired range in superheat may be obtained, and at no time will there be danger of water in the steam, if the cooling water is taken from the boiler circuit.

For providing auxiliary steam, the almost universal practice afloat today, in the higher temperature installa-

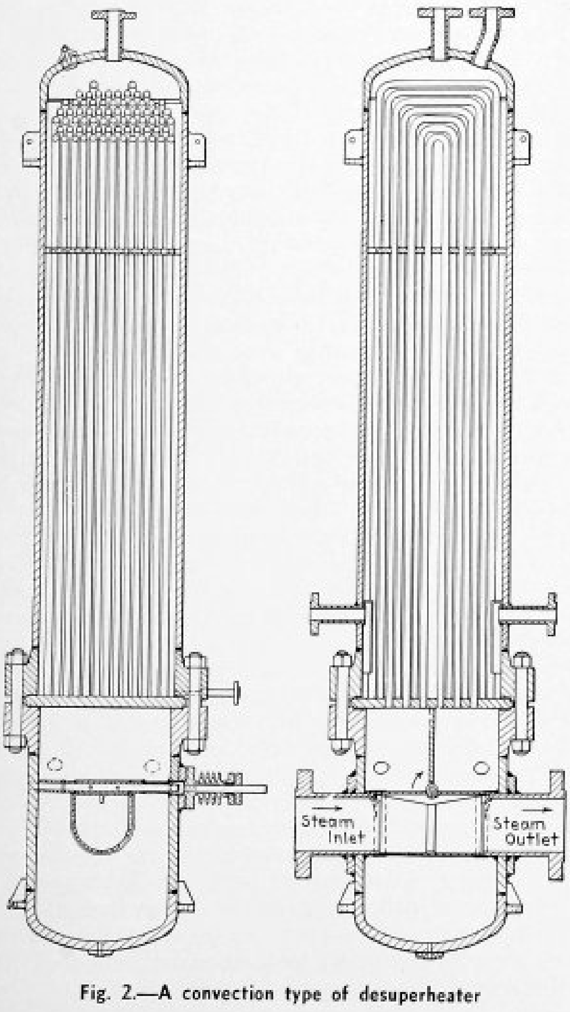


Fig. 2.—A convection type of desuperheater

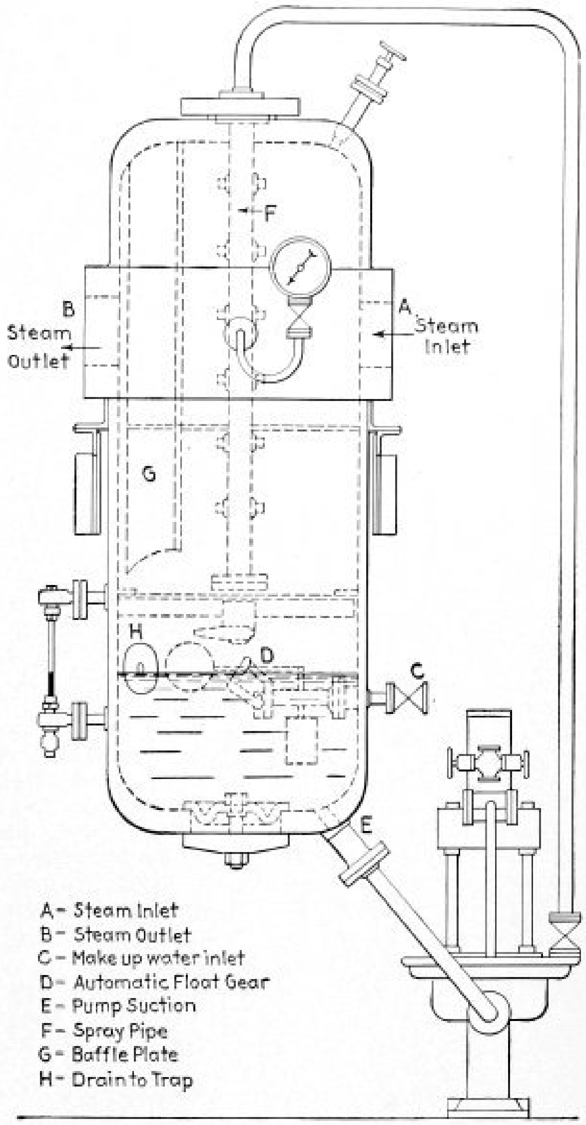


Fig. 3.—Spray-type desuperheater for supplying auxiliary steam

tions, is to desuperheat a portion of the steam which has been through the superheaters. This may be done with either the convection or injection type of desuperheater. However, it is to be kept in mind that, if proper control of the gas flow over the superheater is provided in the boiler unit, such desuperheaters will be unnecessary and saturated steam for auxiliary purposes may be taken directly from the boiler drum without introducing any hazard to the superheater because of this steam by-passing the superheater under maneuvering conditions.

If auxiliary desuperheaters are necessary, unquestionably the simplest and lightest weight type is a coil of pipe located below the water level in the steam drum. This lessens accessibility in the drum, and also leaves the steam with some superheat in it (from 25 to 50 degrees F.), but there are no moving parts and nothing requiring periodic attention. Fig. 1 shows a desuperheater of this type, designed to handle up to 10,000 pounds of steam per hour from 252 degrees F. superheat to 30 degrees F. superheat, located in the steam drum of a header-type boiler.

The spray and surface evaporation types of desuperheaters are more liable to fluctuations in superheat, especially if the primary steam temperature is relatively

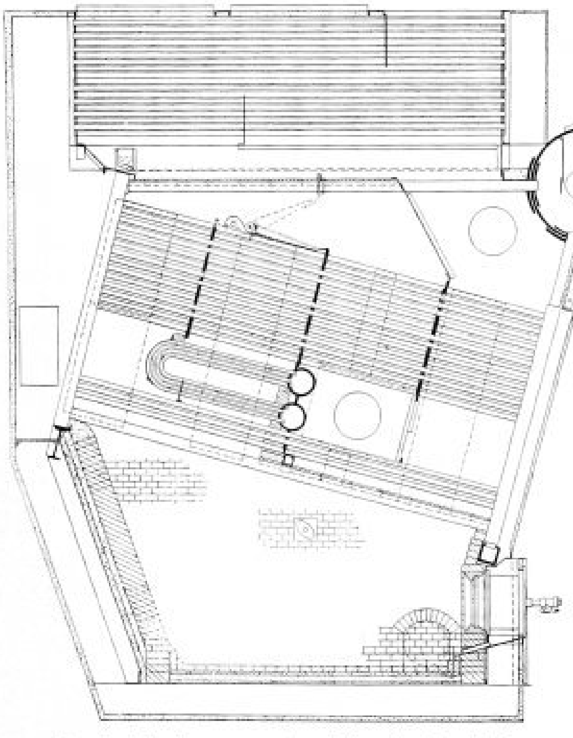


Fig. 4.—Header-type marine boiler fitted with damper for controlling superheat

high; but, on the average, an auxiliary load is fairly steady, which is an important factor in the successful performance of such an installation. Fig. 3 shows a spray-type desuperheater which has found wide application in European marine installations for providing saturated steam to the auxiliaries.

Control of superheat by regulating the flow of gases over the superheater is accomplished in two general ways: (1) By means of dampers, and (2) with separately fired superheaters.

When dampers are used for controlling superheat, they may be located somewhere in the boiler, but usually, for marine service, it has been customary to place them in the uptake. If a damper is located in a boiler, it should be placed far enough from the furnace to prevent the possibility of its overheating and warping at the designed maximum rates of operation. The use of heat-resisting alloys for this purpose will be a good investment in some cases. Also, if the quantity of gas to be controlled is relatively large, it will usually be desirable to install a number of small damper units rather than one large damper. This will appreciably reduce the warping hazard.

Regardless of where they are located, the use of dampers inherently introduces a condition of unbalanced gas distribution through the boiler unit, and in designing units so fitted care should be exercised to avoid the possibility of any damage occurring due to local concentration of hot gases on any portion of the heating surfaces, regardless of damper opening or rating of the boiler.

When raising steam in modern high-temperature boilers, care must always be used to avoid overheating the superheater unit. Restricting the flow of gases over the superheater at this time by means of a damper will reduce the possibility of such overheating and will also make it possible to place the boiler on the line faster than would be the case if the damper were not used.

Controlling Superheat by Gas Flow

In controlling superheat by means of gas flow, it is of course essential that the superheating surface be localized so that the desired control will be obtained.

Fig. 4 shows the application of damper control of superheat to a well-known header type of marine boiler. In this case the second and third passes of the boiler are swept by all of the gases regardless of the damper opening, assuring a relatively flat efficiency curve under all conditions of operation.

Fig. 5 shows one of the larger boilers installed in the U.S.S. *Farragut* type of destroyer. In the installations aboard the ships 49 percent closure dampers were placed in the uptakes above the saturated banks of the boilers only, but in the test boiler of this type at the Naval Boiler Laboratory in the Philadelphia Navy Yard dampers were installed in both uptakes in accordance with the arrangement shown in Fig. 5. The damper located above the saturated bank permitted a total closing of only 49 percent of the uptake area, to eliminate the possibility of damage to the superheater due to excessive restriction of the uptake on this side, whereas the damper above the superheater, when closed, stopped all flow of gas through that side of the boiler.

Unquestionably the ideal way of controlling superheat is by means of separately fired superheaters. It may not always be the most feasible way from a commercial, space, or weight point of view, but as a means of controlling superheat no other method has ever equaled it.

The simplest type of separately fired superheater is one made only of tubes containing the steam to be superheated, the furnace being made large enough so that there will be no danger of local flame impingement with consequent hazard of losing tubes due to such impingement.

When maneuvering a ship with such a unit, the fuel input may be reduced to give any desired superheat, the saturated boilers taking care of the power requirements. When coming in or out of port, the separately fired superheaters may be secured, the steam from the saturated boilers being ideal to meet these requirements. While the ship is in port, only saturated boilers need be on the line.

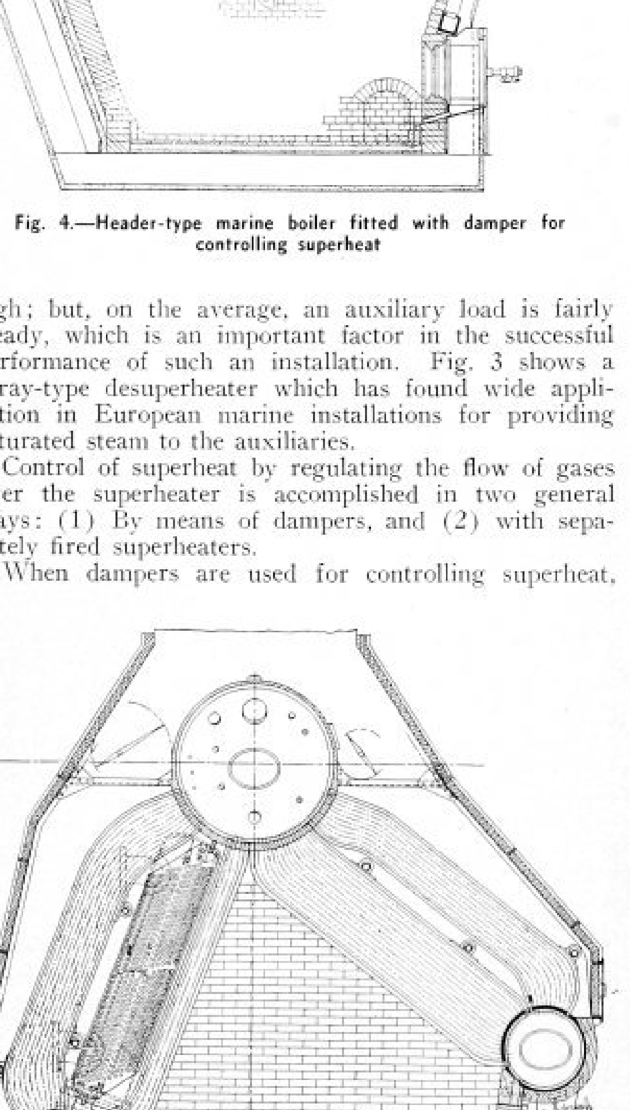


Fig. 5.—U. S. S. Farragut type of boiler at naval boiler laboratory fitted with dampers for controlling superheat

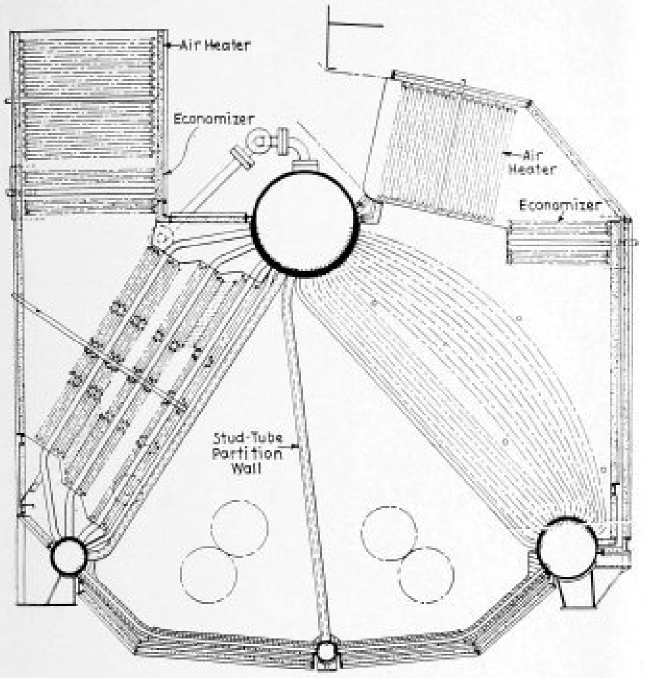


Fig. 6.—Integral separately fired superheater designed to generate steam at 1200 pounds per square inch pressure and 950 degrees F. temperature

The primary disadvantage of the separately fired superheater for marine use is the fact that relatively large powers with a multiplicity of boiler units are desirable for its satisfactory application. To meet this situation the integral separately fired superheater was developed to provide all the advantages of separately fired superheaters, without increasing the number of units in the boiler room of a ship of moderate horsepower.

Fig. 6 shows a unit of this type which has been developed to supply steam at 1200 pounds pressure and 950 degrees total temperature when under way. A further requirement in this particular installation was that 100 percent of full ahead steam be provided for maneuvering purposes at a temperature not to exceed 750 degrees F.

Automatic Combustion Control

For the unit shown in Fig. 6, automatic combustion control is provided which assures any desired steam pressure and temperature over the entire range of boiler rating. Wide range oil burners having no return flow of oil are used. The burners and their air supply on the saturated side of the boiler are controlled by the steam pressure in the boiler drum, the burners and the air supply to them under the superheater side of the boiler being controlled by the temperature of the steam at the superheater outlet.

The gas-tight water-cooled wall separating the saturated and superheater sides of the furnace is of the Babcock & Wilcox Company stud-tube design having refractory surfaces exposed to the furnace which assist in maintaining the combustion efficiency in the small furnaces available in marine work and also reduce the heat absorption per square foot of wall, so that there is little danger of local overheating of the wall tubes even in the burner zone.

Control of superheat is an accepted necessity in the modern steamship. Applying the most feasible control from a practical operating and efficiency point of view is the problem facing the naval architect and owner. There are a number of ways of doing it, and each installation must be carefully analyzed to insure that the procedure followed is the best for the particular service.

Welded Ore Jigs for New Guinea

Two modern developments, the airplane and the electric-arc process of welding, enabled delivery of 20 mineral separation jigs from the coast of New Guinea across a range of mountains to the dredge location, 60 miles inland. Planes provided transportation, the electric arc provided minimum weight. The jigs were manufactured by the Ozark Engineering Company, Joplin, Mo., to the design of F. N. Bendelari, the inventor.

These mining jigs are used for many different mineral separations. The material worked varies from 1-inch gravel for concrete aggregate to the gold saved by jigs on gold dredges. Lead, zinc, scheelite, magetic tin, and manganese ores are also concentrated by this equipment.

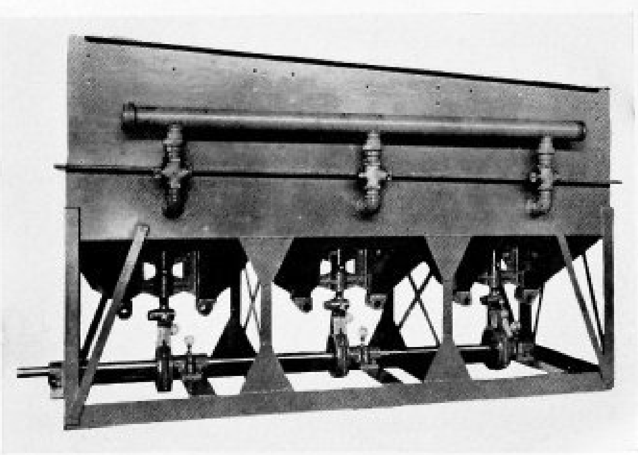
The jig illustrated in the photograph is 42-inch 3-cell placer type, 10 feet long, 4 feet wide and 7 feet high. It is welded of $\frac{5}{16}$-inch steel plate and weighs 6100 pounds. Another type is the 42-inch, 3-cell standard type ore jig. This type is identical in overall dimensions to the placer type but is constructed of $\frac{3}{8}$-inch plate, and weighs 8750 pounds. Only by welding was it possible to provide low weight without sacrifice of strength.

The arc-welded construction of the jigs illustrated utilizes standard rolled steel plate and shapes. Welding was done with Lincoln Electric equipment. These materials were merely cut to exact size and welded together into one integral unit with the electric arc.

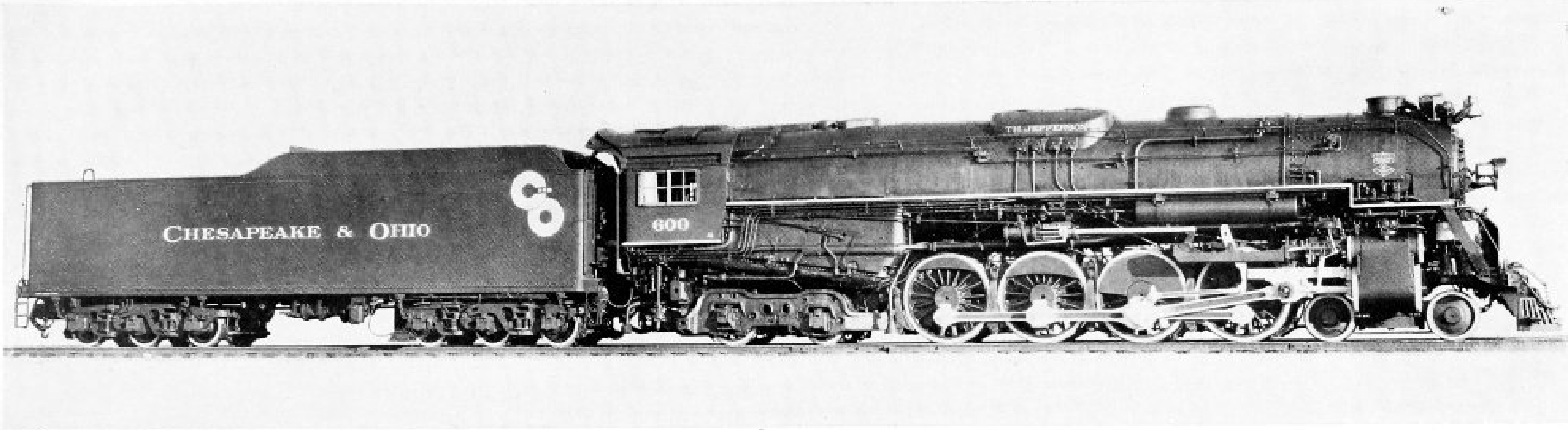
The jig bases consist of standard mill shapes. The two longitudinal members and six bearing supporting members are of equal size. End cross pieces are channels. For the upright members standard angles are employed.

Arc welding, in addition to providing minimum weight, permitted considerable savings in time and cost of construction. No time was required in drilling or punching parts since the electric arc joined steel to steel without use of intermediate connecting members. This simplified construction, reduced detailing, laying out, handling and assembling.

In loading the units into planes, each jig was lifted by derrick at the landing field and lowered through a hatch provided in the top of the plane. One jig was carried at a time. The distance flown was 60 miles and the altitude attained was between 6000 and 8000 feet depending on weather conditions in crossing a range of mountains.



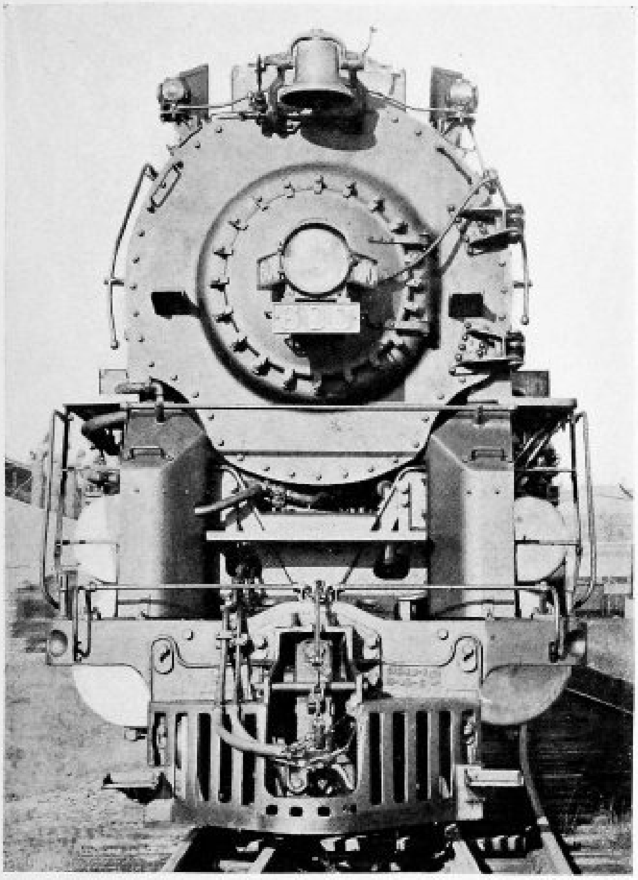
One of twenty jigs carried to interior of New Guinea by airplane



Chesapeake & Ohio 4-8-4 type locomotive, Class J3, designed for heavy passenger traffic built by Lima Locomotive Works, Inc.

General dimensions, weights and proportions

Railroad	C. & O.
Builder	Lima Loco. Wks., Inc.
Type of locomotive	4-8-4
Number of locomotives	5
Road class	J-3
Road numbers	600-604
Date built	1935
Service	Passenger
Dimensions:	
Height to top of stack, ft. and in.	15-4½
Height to center of boiler, ft. and in.	10-5½
Width overall, in.	126
Cylinder centers, in.	91½
Weights in working order, lb.:	
On drivers	273,000
On front truck	89,500
On trailing truck	53,000 Front 61,000 Back
Total engine	477,000
Tender, loaded	381,700
Wheel bases, ft. and in.:	
Driving	19- 3
Rigid	12-10
Front truck, in.	88
Trailing truck, in.	78
Engine, total	46-10½
Engine and tender, total	98- 5¼
Wheels, diameter outside tires, in.:	
Driving	72
Front truck	36
Trailing truck	36 and 44
Engine:	
Cylinders, number, diameter and stroke, in.	2-27½ × 30
Valve gear, type	Walschaert
Valves, piston type, size, in.	14
Maximum travel, in.	7½
Steam lap, in.	1⁵⁄₁₆
Exhaust clearance, in.	³⁄₁₆
Lead, in.	¼
Cutoff in full gear, per cent	79.7
Boiler:	
Type	Conical
Steam pressure, lb. per sq. in.	250
Diameter, first ring, outside in.	91¹¹⁄₁₆
Diameter, largest outside in.	100
Firebox, length, in.	150¹⁄₁₆
Firebox, width, in.	96¼
Height mud ring to crown sheet, back, in.	67½
Height mud ring to crown sheet, front, in.	95¾
Combustion chamber length, in.	54
Arch tubes, number and diameter, in.	2-3½
Thermic Syphons, number	2
Tubes, number and diameter, in.	65-2¼
Flues, number and diameter, in.	220-3½
Length over tube sheets, ft. and in.	21-0
Net gas area through tubes and flues, sq. ft.	10.6
Fuel	Soft-coal
Grate area, sq. ft.	100
Heating surfaces, sq. ft.:	
Firebox and combustion chamber	396
Arch tubes and Thermic Syphons	129
Firebox, total	525
Tubes and flues	5,013
Evaporative, total	5,538
Superheating (Type E)	2,342
Combined evap. and superheat	7,880
Tender:	
Style or type	Rectangular
Water capacity, U. S. gal.	22,000
Fuel capacity, tons	25
Trucks	6-wheel
Journals, diameter and length, in.	7 × 14
General Data, estimated:	
Rated tractive force, main engine, lb.	66,960
Rated tractive force, booster	14,075
Total rated tractive force, lb.	81,035
Speed at 1,000 ft. per min. piston speed, m.p.h.	42.85
Piston speed at 10 m.p.h. ft. per min.	233
R.p.m. at 10 m.p.h.	46.7
Boiler evap. (with heater) (Cook) lb. per hr.	79,640
Equiv. evap. per sq. ft. evap. h.s. per hr.	14.38
Weight proportions:	
Weight on drivers ÷ weight engine, per cent	57.2
Weight on drivers ÷ tractive force	4.08
Weight of engine ÷ evaporation	5.99
Weight of engine ÷ comb. heat. surface	60.53
Boiler proportions:	
Firebox h.s. per cent comb. h.s.	6.7
Tube-flue h.s. per cent comb. h.s.	63.6
Superheat. surface per cent comb. h.s.	29.7
Firebox h.s. ÷ grate area	5.25
Tube-flue h.s. ÷ grate area	50.13
Superheat. surface ÷ grate area	23.42
Comb. h.s. ÷ grate area	78.80
Gas area, tubes and flues ÷ grate area	0.11
Evaporation ÷ grate area	796.4
Tractive force ÷ grate area	669.6
Tractive force ÷ evaporation	0.84
Tractive force ÷ comb. h.s.	8.50
Tractive force × dia. drivers ÷ comb. h.s.	6.12



Front view of C. & O. 4-8-4 type locomotive

Lima Builds C. & O. Locomotives

Of the few steam locomotives built in 1935 the five of the 4-8-4 type from the Lima Locomotive Works, Inc., for the Chesapeake & Ohio represent the outstanding design. These locomotives, which are the first with this wheel arrangement to be used on the C. & O., are numbered from 600 to 604, inclusive, and are known as the "Greenbrier" type, or Class J-3. In addition to being numbered each locomotive has been given the name of a person who formerly lived in the territory served by the road and whose fame is nation wide. The names of those chosen were Thomas Jefferson, Patrick Henry, Benjamin Harrison, James Madison and Edward Randolph.

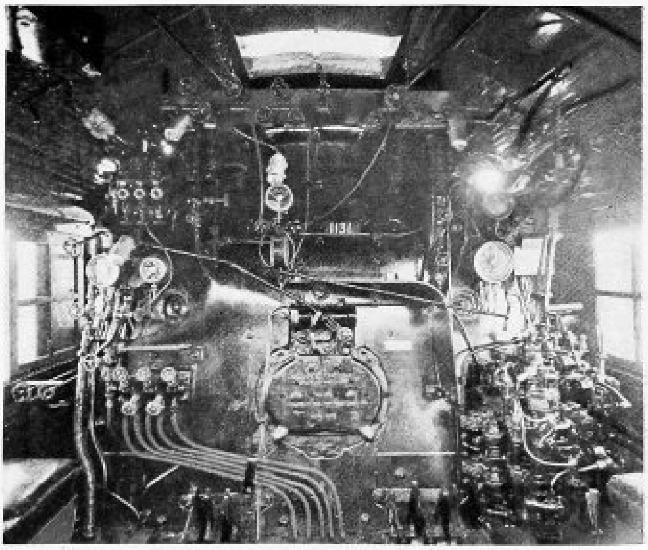
The service for which these locomotives were designed is the handling of heavy through passenger trains on the main line between Hinton, W. Va., and Charlottesville, Va., a distance of 175 miles.

These locomotives have the largest combined heating surface of any locomotive of this type thus far built; namely, 7880 square feet. The high total and the relatively high percentage of radiant heating surface is relied upon to produce a heat transfer which, combined with care throughout the design to effect high economy in the utilization of steam in the cylinders, is expected to provide a locomotive capable of developing not less than 5000 cylinder horsepower.

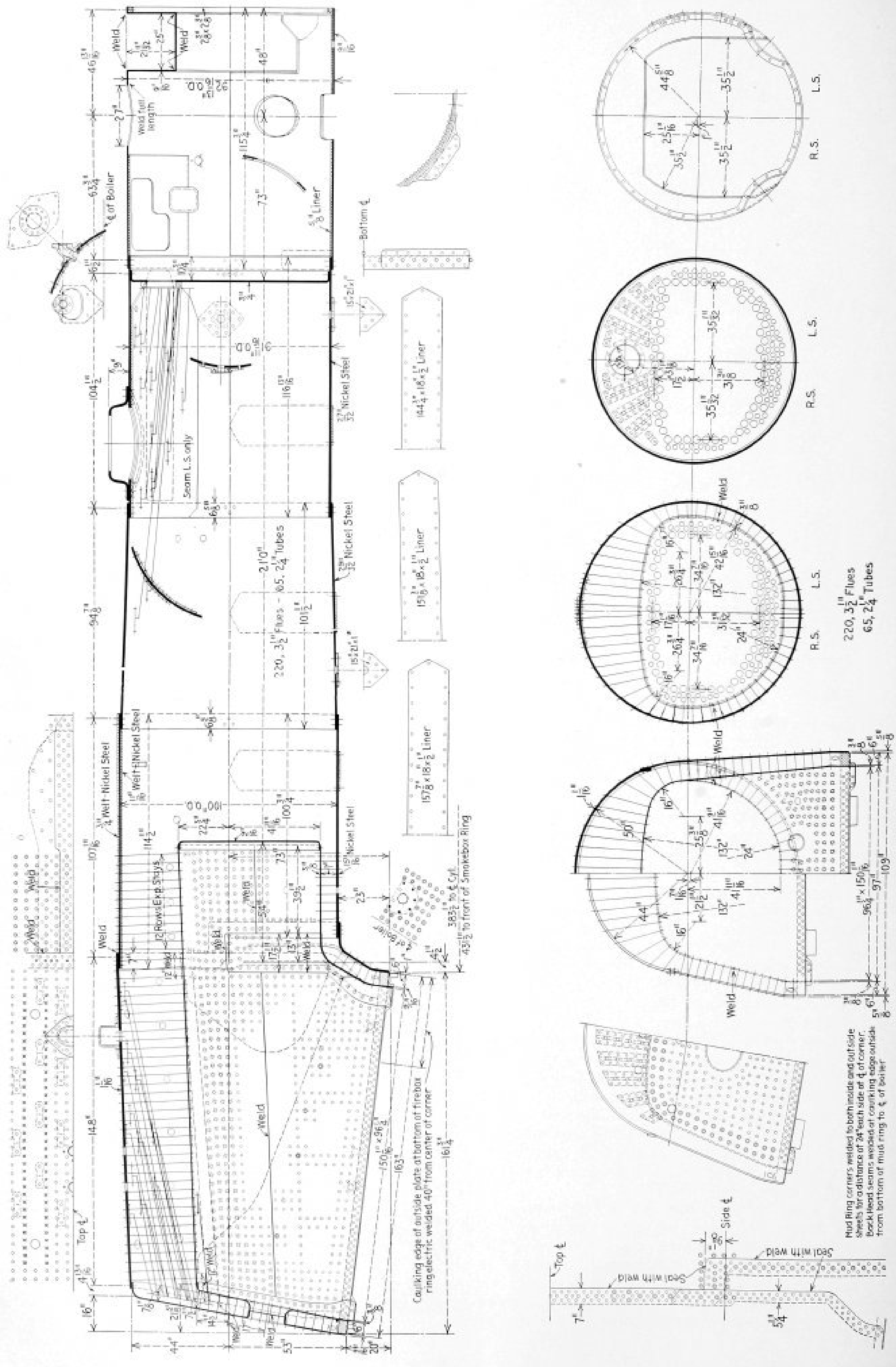
The boiler, which carries a pressure of 250 pounds per square inch, but is designed for a maximum of 260 pounds, is of unusually generous capacity and, using the Cook formula, has an estimated evaporative capacity of 79,640 pounds per hour, including an eight percent allowance for the feedwater heater. In addition, the design provides the largest steam space possible within the clearance limit.

Boiler Details

The shell, which is of the conical type, is made up of three courses of nickel steel. The first is 91 11/16 inches in outside diameter and 27/32 inch thick; the second, which is tapered, is 29/32 inch thick, and the third, which extends to the throat, is 100 inches in outside diameter and 15/16 inch thick. The firebox, which has a combustion chamber 54 inches long, contains two thermic syphons which are supplemented by two arch tubes for the support of the Security brick arch. The crown sheet has a slope of 8¼ inches and a space of 29½ inches is provided between the crown sheet and the roof sheet. There are 65 2¼-inch tubes and 220 3½-inch flues, the length over tube sheets being 21 feet. The dome, with an opening 32 inches in diameter and a height of only 9 inches, is located on the first shell



View in cab of back boiler head and fittings



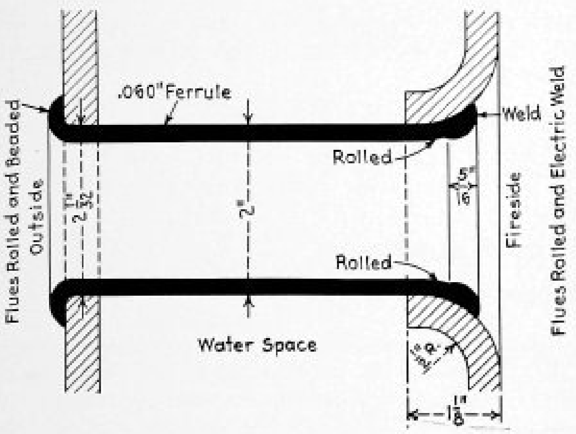
Longitudinal and transverse sections through boiler of Chesapeake & Ohio passenger locomotive

course, 6 feet 7/8 inch back of the tube sheet. The total length of the boiler, including the smokebox, which is 121 inches long, is 49 feet 5¼ inches.

The grate has an area of 100 square feet and a slope from back to front of 20 inches. The grates are of the Firebar type and the coal is fed by a Standard Type MB stoker. Six combustion tubes are provided, three on each side.

The boiler is fitted with the Elesco Type E superheater, with the American multiple throttle and a Worthington type 5-S feedwater heater of 9000 gallons capacity. The drypipe is of 10½ inches inside diameter. Superheated steam is used for the blower. All other auxiliaries are operated by saturated steam taken from a cast-steel cab turret. The safety valves are mounted on a cast-steel turret attached to the roof sheet.

Welding has been employed at many points in the construction of the boiler. In the firebox the crown



Detail construction of the combustion tubes

sheet is butt-welded to the side sheets, the bottom sheet of the combustion chamber is butt-welded to the crown sheet, the thermic syphons are welded to the crown and throat sheets, the inside throat sheet is butt-welded all around, the firedoor sheet seams are butt-welded from the bottom of the mud ring up to the center line of the boiler and the firedoor hole seam is butt-welded. The mud ring calking edges are seal welded to both inside and outside sheets for a distance of 24 inches from each side of the center line of the corner, except at the front where the outside sheet is seal welded longitudinally for 40 inches back from the corner. The back head seams are sealed by welding from the bottom of the mud ring to the top of the seam between the outside wrapper and the side sheets, the outside wrapper and side-sheet seams are seal welded at the throat connection from the bottom of the mud ring on one side over the top of the boiler and down to the bottom of the mud ring on the other side, the throat seam to the third sheet course is completely seal welded, the longitudinal boiler seams are seal welded at each end for a distance of 12 inches, and the outside butt-strap on the third course longitudinal seam is seal welded in the stayed zone of the combustion chamber. In addition, the combustion tubes are seal welded on the fire side, all tubes and flues are welded at the firebox end and the staybolt MK caps and UW sleeves are welded.

The rectangular water bottom tender has a capacity for 25 tons of coal and 22,000 U. S. gallons of water. It is carried on two Buckeye type, six-wheel trucks and has a loaded weight of 381,700 pounds.

Special Boiler Equipment Applied on C. & O. 4-8-4 Type Locomotives

Builder	Lima Locomotive Works, Inc.
Road Numbers	600-604
Boiler:	
Boiler, steel, nickel	Lukens Steel Co.
Firebox steel, firebox, crown and side	Otis Steel Co.
Staybolts, flexible (Welded)	Flannery Bolt Co.
Thermic Syphons	Locomotive Firebox Co.
Brick arch (Security)	American Arch Co.
Superheater (type E)	Superheater Co.
Throttle valve, multiple	American Throttle Co.
Feedwater heater (type 5S)	Worthington Pump & Machy. Corp.
Injector, live steam	Nathan Mfg. Co.
Grates (Firebar)	Waugh Equipment Co.
Stoker (type MB)	Standard Stoker Co.
Firedoor (Butterfly 8A)	Franklin Ry. Supply Co.
Blowoff cocks, 2 in.	Wilson Engineering Corp.
Plugs, arch tube	Huron Manufacturing Co.
Plugs, throat sheet, syphon	Housley Flue Connection Corp.
Plugs, washout	Huron Manufacturing Co.
Steampipe casing (Flextite)	American Locomotive Co.
Hinges, smokebox	Okadee Co.
Lagging (85 percent magnesia)	Johns-Manville Sales Corp.
Cab Fittings and Boiler Mountings:	
Safety valves	Consolidated Ashcroft Hancock Co.
Water column	Nathan Mfg. Co.
Whistle	Nathan Mfg. Co.
Bell ringer (improved Golmar)	Viloco Ry. Equipment Co.
Sanders	Viloco Ry. Equipment Co.
Reducing valve, steam heat	Gold Car Heating Co.
Headlight generator	Pyle National Co.
Headlight case	Pyle National Co.
Windows, storm	Prime Mfg. Co.

Promoting Industrial Safety

The extent of efforts to make the American worker safety conscious is brought out in a nation-wide investigation of industrial relations policies made by the National Industrial Conference Board. The survey covered 2452 business establishments in manufacturing, mining, transportation and communication, wholesale and retail trade, finance and public utilities. Employment represented by these companies totals over 4½ million. A total of 1429 companies reported organized safety programs. These companies employ 3,742,000 workers or 83 percent of the total number covered in the survey.

Safety committees are functioning in 1200 of these companies. These committees, consisting of management representatives, foremen, and key employes have as their special responsibility the elimination of accident hazards in the plant, proper safeguarding of machinery, and eduction in safety methods.

In 474 of these companies safety contests are carried on. These contests, by introducing an element of competition between departments or plants, seek to reduce lost-time accidents to a minimum.

Organized safety work is considerably less prevalent in very small than in larger establishments. Only 29 percent of companies employing fewer than 100 workers reported safety programs as compared with 55 percent of companies employing 100 to 999, 75 percent of companies employing 1000 to 4999, and 87 percent of companies employing more than 5000.

Among industrial groups, the highest proportion of companies with organized safety programs is found in the public utility group including transportation, communication, gas and electric power companies. In this group 85.4 percent of the companies covered by the survey have such programs. Petroleum refining ranks next with 83.8 percent. In manufacturing industries the proportions range from 75 percent in rubber manufacturing to 28 percent in the manufacture of clothing. In only 3 of the 16 manufacturing classifications is the proportion of companies with organized safety programs lower than 50 percent and in 5 it exceeds 70 percent.

A very small proportion of safety programs has been discontinued. The elimination of safety committees was reported by 25 companies, which is equivalent to only 2.1 percent of total number of such committees reported as still in operation. Safety contests have been abandoned by 40 companies, or 8.4 percent of the number of such programs reported as in force.

Work of the A.S.M.E. Boiler Code Committee

The A.S.M.E. Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the code is requested to communicate with the secretary of the committee, 29 West 39th St., New York.

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published.

Following are records of the interpretations of this committee formulated at the meeting of December 6, 1935, and approved by the council.

Case No. 756 and Case No. 757—(*Annulled*)

Case No. 808—(*Interpretation of Par. H-24*)

Inquiry: (*a*) May the provisions of Par. P-216 be applied to heating boilers as an extension of the provisions of Par. H-24?

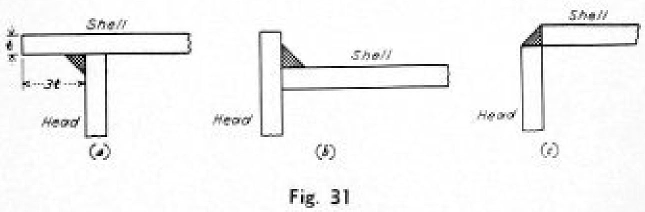


Fig. 31

(*b*) In the case of welded low-pressure heating boilers having unflanged heads, may the provisions of Par. H-24 be applied? If not, what would the requirements be with respect to the area to be stayed and what would be the maximum height of the segment above the tubes?

Reply: (*a*) The provisions of Par. P-216 may be applied to the design of low-pressure heating boilers having flanged heads.

(*b*) Excepting only the allowance of 2 inches above the tubes, the provisions of Par. H-24 may not be applied to the unflanged flat heads of welded heating boilers with the exception that unflanged flat heads inserted in the shell at least $3t$ (see Fig. 31 *a*) may be considered the equivalent of flanged heads (t = shell thickness). For flat unflanged heads not inserted in the shell (see Figs. 31 *b* and *c*), the maximum distance from the top row of tubes to the shell must not exceed $1p$ without staying.

Case No. 813—(*Interpretation of Pars. P-198a and P-268a*)

Inquiry: (*a*) Will a flat head having a flange which is screwed over the end of a shell, pipe, or header be considered acceptable under the rules in Par. P-198*a*?

(*b*) Will a head of this type be subject to the limit of 100 pounds per square inch working pressure specified for threaded joints in Par P-268*a*?

Reply: (*a*) Flat heads attached in the manner described may be considered equivalent to either sketch (*c*) or (*j*) of Fig. P-14½ provided all other requirements thereof are met and all possible means of failure of the threaded joint, either by shear, tension, or compression, due to the hydrostatic end force, are resisted with a factor of safety of five.

(*b*) The limitation referred to in Par. P-268*a* is not intended to apply to threaded joints not connected to external piping.

Case No. 814—(*Interpretation of Pars. U-69 and U-70*)

Inquiry: Do the plate-thickness limitation of 1½ inches in Par. U-69, and ⅝ inch in Par. U-70 apply to all plates that make up the heads and shell of the vessel, or do they apply only to the shell thickness?

Reply: It is the opinion of the committee that the plate-thickness limitations of Pars. U-69 and U-70 apply to shell plates, also to heads when fabricated of more than one piece. They do not apply to heads formed from a single plate.

Case No. 810—(*Annulled*)

Case No. 815 and Case No. 816—(*In the hands of the committee*)

Shim Stock Dispensing Unit

A new Shim stock dispensing unit has been announced by the Laminated Shim Company, to save time and space in stock rooms, tool rooms, and maintenance departments. It also saves cutting space on work benches.

It keeps all sizes of stock together in one place; and by hanging it in the location most convenient for everyone it will save additional time in trips to and from the work. It holds all thin shim stock and 2-inch by 9-inch Laminum strips in a small wall space.

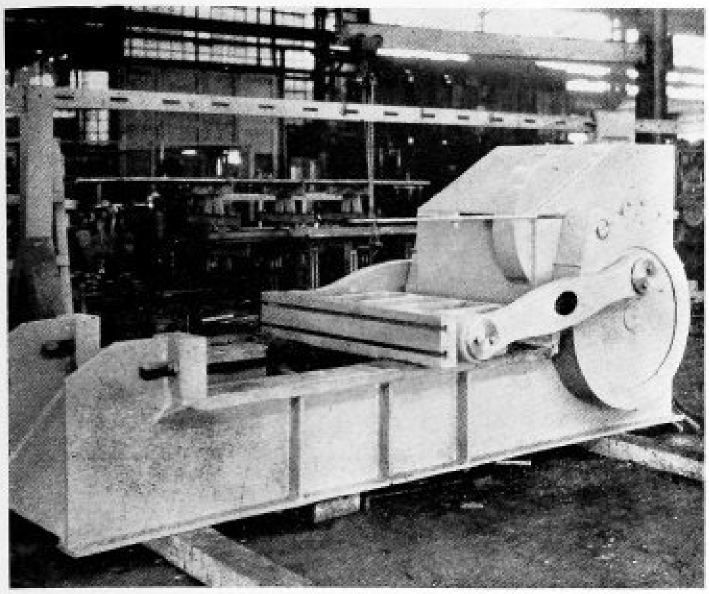
The unit is available without charge, being supplied with a special assortment of shim stock. Write the manufacturers, Laminated Shim Company, Inc., 21-24 44th Avenue, Long Island City, N. Y.

National Metal Congress and Exposition to be held at Cleveland

The 1936 National Metal Congress and Exposition, to be held in Cleveland's public auditorium, will be staged October 19 to 23, inclusive. This was announced definitely by W. H. Eisenman, managing director of the exposition and national secretary of the American Society for Metals, which annually sponsors this event.

"This gives Cleveland one of the year's largest industrial shows," Mr. Eisenman said. "Thirty-five thousand engineers, metallurgists and practical men in the metal industry visited last year's exposition which included the latest developments in metals and their use. Two hundred exhibitors used 175,000 square feet of floor surface to exhibit their products."

The National Metal Congress and Exposition are regarded as the educational opportunity of the year for the metal man. Five great technical societies co-operate to stage this annual event. They are the American Welding Society, the Wire Association, the Institute of Metals and Iron and Steel divisions of the American Institute of Mining and Metallurgical Engineers, and the American Society for Metals. The annual conventions of these societies will also be held at this time.



Bulldozer fabricated by arc-welding

Heavy Machine Welding

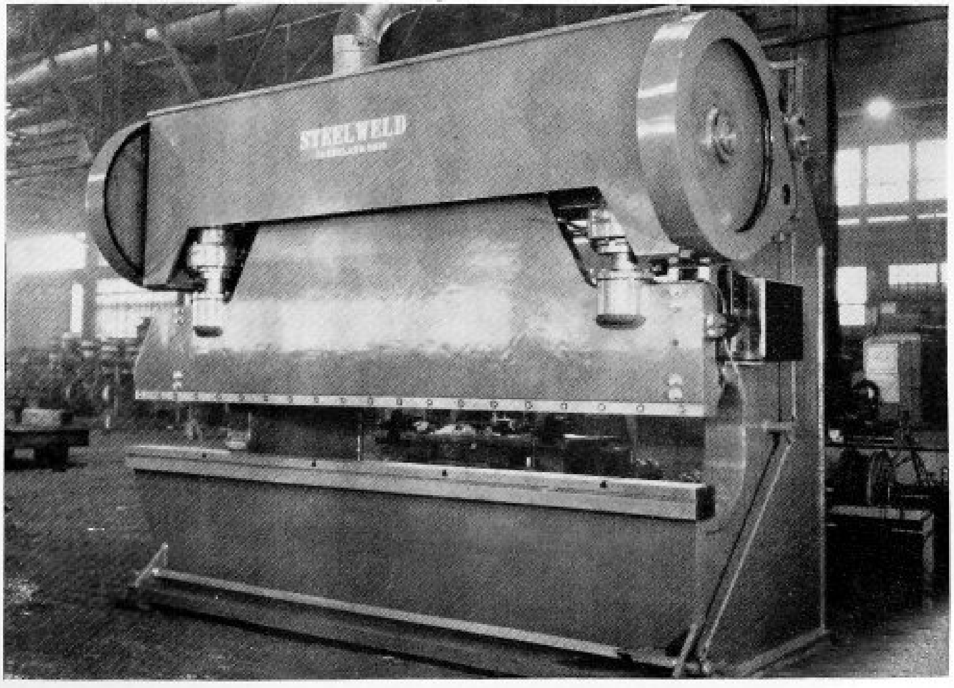
Bending Brakes and Bulldozers

Not to obtain lower costs or more rapid production, but, as a means of assuring a better, sturdier product, the Steelweld Machinery Company, Cleveland, has turned to all-welded construction in the bending brakes and bulldozers that it manufactures.

Bending brakes are subject to many kinds of abuse. With older designs, an unnoticed piece of stock in the bottom of a die, or the setting of a ram a little too close, might result at any time in sufficient overload to fracture a housing or to cause misalinement. New parts could not always be obtained quickly and such mishaps frequently meant a serious loss of time, or a badly disrupted production schedule, for the shop using the machine.

While more costly than previous methods, all-welded construction of the Steelweld Machinery Company brakes provides machines that, the manufacturer claims, cannot be damaged by ordinary accidental overloads. Housings, which in previous models had been simple steel plates, are now carefully designed box sections with much deeper throats. Beds, rather than being just slabs of steel, have evolved into heavy I sections. Crowns, instead of merely taking bearing thrusts, have become integral parts of the beds and give added rigidity to the entire machine. The net result is a monolithic structure that is said to have maximum strength where strength is needed most. Such a structure was impossible to build with castings or with the type of slab steel construction formerly used.

Additional features made possible by re-designing for welding are: (1) deep gaps in the housings to permit the bending of wide plates, even wider than the machine itself, (2) a shallow bed, no deeper than floor level, which eliminates all need for special foundations, (3)



Bending brakes of welded design are more rugged than older types, and it is claimed they cannot be damaged by overloading wider housings, providing extra lateral rigidity and preventing deflections. Under excessive overload, allowable deflections culminate rapidly in the motor before becoming great enough to cause a permanent "set" in the members. A 20 percent speed loss stops the machine before any damage occurs.

Similar re-designing of the bulldozers made by this company has resulted not only in additional strength, but also in such improvements as a bronze-bushed roller and ram running in ground steel ways.

Murex heavy mineral coated electrodes are used throughout in the welding of these machines and particular pains are taken to assure welds of the highest quality. Operators are carefully trained and their work thoroughly inspected.

An unforeseen advantage gained through the new type of construction, says this manufacturer, is a decided improvement in appearance. No conscious effort was made along these lines, but, the natural consequence of placing motors inside out of harms way, keeping projections and moving shafts away from work and workmen, putting a sturdy crown around eccentrics, and moving flywheels from their usual outside positions to safer mountings inside housings, is a handsome machine whose clean lines convey an impression of ample capacity.

Robert E. Kinkead to Survey Welding

Robert E. Kinkead, well-known consulting engineer on welding, has been retained by the Carnegie-Illinois Steel Corp., Pittsburgh, to make a survey of its welding operations. Mr. Kinkead, a graduate of Ohio State University in 1913, is a mechanical engineer, and has specialized in welding throughout his entire career. Since 1927 he has been engaged in professional consulting work for a number of engineering and manufacturing concerns.

Boiler Manufacturers to Meet in Cleveland

The mid-winter meeting of the American Boiler Manufacturers Association and Affiliated Industries is to be held at the Cleveland Hotel, Cleveland, on Thursday, February 20.

The regular business of the Association will include a statement by the president, committee reports and miscellaneous matters of interest. It will be followed by an illustrated lecture by James F. Lincoln, president of the Lincoln Electric Company, Cleveland, on the subject "Electric Welding as Applied to Pressure Vessels." C. J. Stilwell, vice-president of the Warner & Swasey Company, Cleveland, will also speak on "The Advantages of Co-operation within an Industry."

Affiliated Branches of A.B.M.A.

The Class One Welding Association, the Watertube Branch and other sections of the A.B.M.A. will also hold meetings at the same time and the program for these events is as follows:

Monday, February 17
- 2:00 P.M. Board Meeting Class One Welding Association

Tuesday, February 18
- 9:30 A.M. Annual Meeting Class One Welding Association
- 12:30 P.M. Luncheon

Wednesday, February 19
- 9:00 A.M. Watertube Branch of A.B.M.A.
- 3:00 P.M. Pulverized Fuel Equipment Branch of A.B.M.A.

Thursday, February 20
- 9:00 A.M. A.B.M.A. Mid-Winter Meeting
- 2:00 P.M. H.R.T. Branch of A.B.M.A.

Orders Placed for new Locomotives

The Bessemer & Lake Erie Railroad Company and the Union Railroad Company, Pittsburgh, awarded contracts during the first week of February for the construction of 24 steam locomotives to three locomotive builders at a cost of approximately $2,300,000.

Of this number the Baldwin Locomotive Works will build ten Texas 2-10-4 type heavy freight locomotives and five heavy 0-10-2 type switching locomotives.

Four 0-8-0 type switching locomotives will be built by the American Locomotive Company and five 0-6-0 type switching locomotives will be built by the Lima Locomotive Works.

Republic Steel Offices Moved to Cleveland

Effective January 25, the general offices of the Republic Steel Corporation were removed from Youngstown, O., to Cleveland, as recently announced by T. M. Girdler, president and chairman of the board of Republic. The move consolidates the general offices which have been located in Youngstown, the executive and Cleveland district sales offices, already in Cleveland and the advertising department, formerly in Massilon, O.

Changes in personnel have also taken place in Republic as Charles W. East has been appointed district sales manager of Republic Steel Corporation at Houston, Tex. Mr. East leaves his post as assistant manager of sales in the pipe division immediately to establish his headquarters in Houston.

The appointment of R. H. Sonneborn as special sales representative of the Tubular Division of Republic Steel Corporation has also been announced. Mr. Sonneborn, whose appointment takes place immediately, will have headquarters in the Republic Building, Cleveland, O. After being graduated from the University of Michigan Mr. Sonneborn became associated with the Colorado Fuel and Iron Company. His affiliation with Republic follows ten years of experience with Youngstown Sheet and Tube Company in the Detroit area.

Toledo Plant to Produce Iron Plate Paving

The Interlake Iron Company, Toledo, O., has announced that contracts totaling $100,000 have been let and work begun on its new plant for the production of iron paving plates. It will be the first plant of its kind in the United States.

The new form of paving was one of the big features of the Highways Exposition recently held in Cleveland. It is reported to be virtually non-skid and wear-proof. Exhaustive tests have proved iron plate paving to be as much as five times more durable than other paving material, outwearing even granite blocks. It is also said to reduce wear on automobile tires. In price, the iron paving compares favorably with brick, asphalt and other materials. It has been used successfully in Europe for a number of years.

The iron plate is constructed in the form of a 10½-inch triangle and is one and three-eights of an inch in overall thickness. Around the outer edge of the bottom of the plate is a flange about one inch deep and one-half inch thick, with air space in the center for anchoring in a concrete base.

E. L. Clair, general manager of the Toledo firm, stated that the present expenditures were for a preliminary plant which, if the product meets with the public response anticipated, will lead to a huge development in Toledo.

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

VOLUME XXXVI NUMBER 2

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Contents

Industrial Board Reports Trade Gains

The National Industrial Conference Board, New York, after analyzing 1935 statistics, with late December estimated, reports the following: 86.1 percent increase for machine tool orders, 45 percent for automobiles, 30.6 percent for steel ingots and 19.5 percent for total construction.

Engineers Hear Talk on Metal Spraying

The St. Louis Engineers' Club at a meeting on January 30, heard Mr. Ryan, vice-president of the John Nooter Boiler Works, St. Louis, Mo., deliver a talk on metal spraying. He covered the history, description of the process, results of metal spraying and told of numerous applications. He also described a number of successful jobs that were accomplished for corrosion resistance as well as for building up shafts, pumps, rotors, etc. A number of slides were shown and a variety of miscellaneous sprayed work was put on exhibition for the inspection of the engineers, including built up shafts, sprayed glass, sprayed granite and other objects.

Pipe Contract Awarded

It has been reported that the Continental Oil Company, Ponca City, Okla., has awarded a contract to the Apex Construction Company to construct by the oxy-acetylene process a 45 mile, 8-inch diameter pipe line from Lake Charles to Basile, La.

Steel Industry to Modernize Equipment

The steel industry will spend approximately $200,000,000 for modernizing equipment and for new finishing capacity in 1936, Walter S. Tower, Executive Secretary of American Iron and Steel Institute, said in an address before the California State Chamber of Commerce at Del Monte, Cal. on February 6.

"The expected outlay this year compares with $140,000,000 in 1935," said Mr. Tower. "These expenditures will add little or nothing to the capacity of the industry to produce raw steel. Practically every dollar is being spent to improve methods of manufacture and to make a better product for the customer."

According to Mr. Tower, employment in the steel industry has reached a figure approximating the total number of employees in the years of peak activity in 1928 and 1929.

Trade Publications

Pipe Bulletin.—A bulletin has recently been published by Bethlehem Steel Company, Bethlehem, Pa., covering the subject of pipe manufacture from the standard of quality.

Sheet Metal Tools.—The Niagara Machine & Tool Works, Buffalo, N. Y., has published its latest catalogue covering a complete line of Niagara machines for cutting circles and rings and for slitting and flanging. These machines find wide application in the sheet metal and boiler construction industry.

Portable Electric Tools.—The Chicago Pneumatic Tool Company, New York, has recently brought out a catalogue covering the complete line of Hicycle portable electric tools. These tools consist of drills of all description, reamer and drill combinations, screw drivers, nut runners, stud setters, tappers, grinders and polishers.

Crane Supplement to Timken Engineering Journal.—This publication issued by the Timken Roller Bearing Company, Canton, O., illustrates typical layouts for the application of Timken tapered roller bearings to all types of crane machinery. This supplement, 8½ by 11 inches, punched to fit a standard three-ring binder, will be found extremely useful in making up primary drawings and tentative Timken bearing selections.

Baldwin Locomotives.—The Baldwin Locomotive Works, Philadelphia, Pa., has just issued its quarterly bulletin which contains a description of the new Pennsylvania electric locomotives and other recent Baldwin products. The publication also has an interesting article covering the investigation of locomotive boilers and fireboxes in regard to the quality of construction and material and the effect of these properties on the life and maintenance costs of a locomotive.

Questions and Answers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Boiler Tubes—Thermic Syphons

Q.—Would be interested to know what tubes and flues the railways use in U. S. A. There seems to be a divided opinion in the Far East *re* this. Some advocate lap-welded charcoal iron tubes. Others go out for cold-drawn weldless steel. I think the Superheater Company does this. Chinese railways use 2-inch outside diameter fire tubes, 5⅜-inch outside diameter superheater flues, 3-inch arch tubes.

Would also be interested to know more about thermic syphons, their maintenance and up-keep. We have had considerable trouble with several boilers fitted with Nicholson thermic syphons due to cracking. Any information supplied through your instructive BOILER MAKER AND PLATE FABRICATOR would be much appreciated.—F. T. T.

A.—Seamless steel tubes are used in the majority of locomotive boilers in the United States. The advantages being in their exceptional ductility and uniform density and soundness due to the method of manufacture.

The principal thing required in maintaining thermic syphons is the systematic washing of the syphons to see that they are kept perfectly clean.

Not much trouble will be experienced with the diaphragm plate if flexible staybolts are properly applied around it. You will find that it is very essential that all parts of the syphon are kept clean. We believe that the district or section of the country in which locomotives operate must govern, and we are quite sure that if the rules outlined by the manufacturer of the thermic syphon are followed little trouble will be experienced. This calls for the interiors of syphons to be washed and cleaned, as well as the bottom of the exterior at each washout, Fig. 1. In addition in very bad water districts and, where a sand blast machine is in use, the water side of the diaphragm plate at the roll of the flange must be sand blasted about every ninety days with an air pressure on the sand blast machine not over 40 pounds. This is to remove any scale that might accumulate at that point. It is very essential to keep the sheet clean, or the working of the sheet at this point if not protected will perhaps change the structure of the material. This is the cause of the sheet cracking. After the sheet has been sand blasted, air pressure should be used to clean the space between the diaphragm flange and the neck of the syphon so that at all times there will be water at this point when there is fire in the firebox.

General Repairs

Repairs to thermic syphons should be taken care of just as in the case of any other part of the firebox or boiler; that is, repairs are to be made in a safe and satisfactory manner. From reports of forty-five railroads that have had thermic syphons in locomotives two years or longer, 75 percent of syphon repairs are at the diaphragm plate or syphon neck. Cracks develop around the diaphragm plate and on top of the neck. When a circumferential fracture develops in the syphon neck it should not be welded, but a patch applied with proper staybolt spacing in patch. The bottom section of the syphon may be removed and new section applied. In applying this new section regardless of how much of

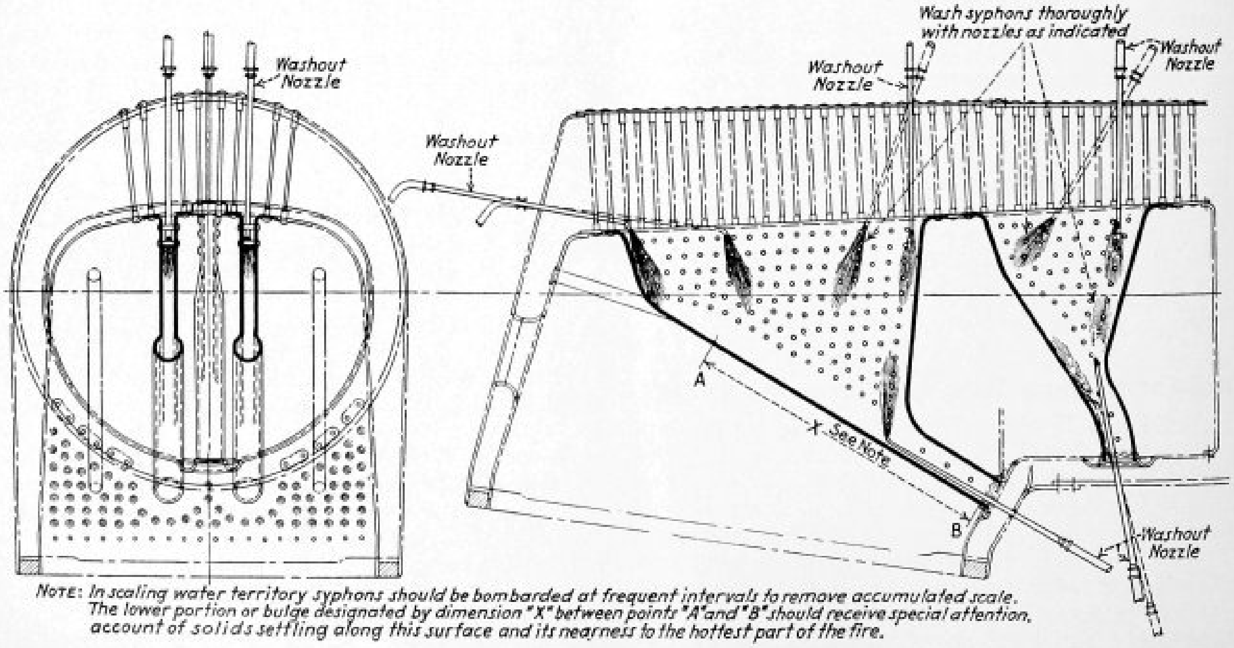

Fig. 1.—Syphons must be thoroughly washed at each washout period

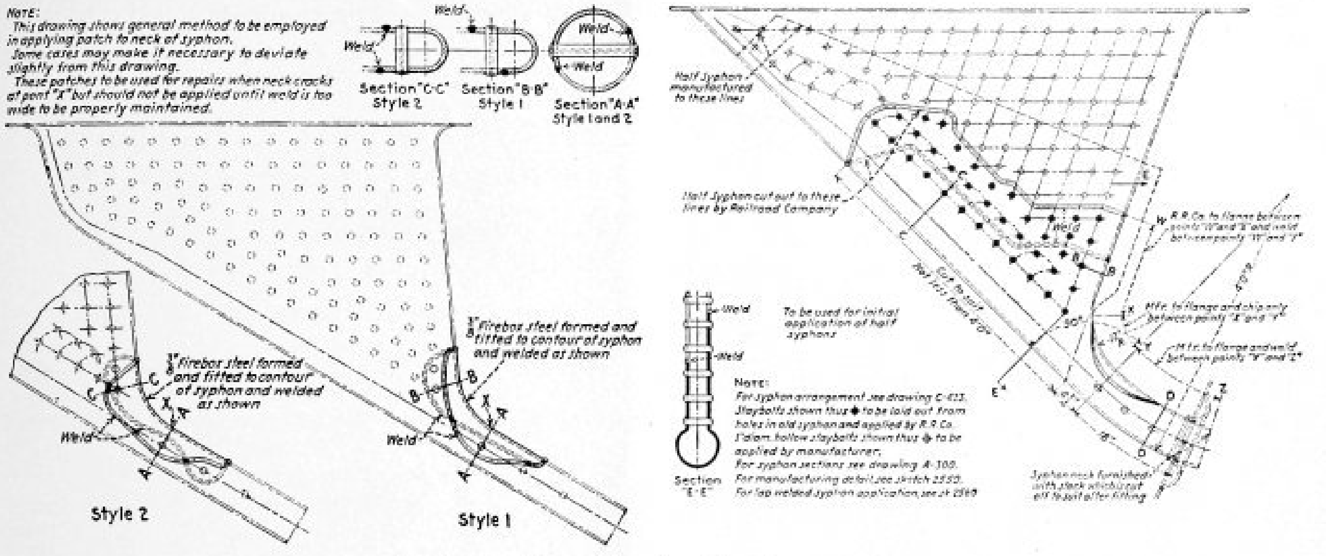

Fig. 2.—Typical methods of patching thermic syphons

the section is removed, the welds, where the new section joins the old section, should not be applied directly opposite each other. The safest method is to have the weld on one side at least two rows of staybolts higher than the weld on the opposite side; or apply the section of the syphon in a saw tooth manner, alternating the so-called teeth in order that staybolts in the teeth will be in the new section on one side and in the old section of the syphon on the opposite side.

When cracks develop in the diaphragm plate these can be readily repaired by cutting out the crack and welding. When a crack or fracture develops which is 40 percent of the circumference of the diaphragm plate, the diaphragm should be renewed. This can be done by burning the diaphragm plate from the syphon neck without injury to the syphon or syphon neck and the new diaphragm plate can be applied the same as in ordinary repairs to any other part of the firebox.

No trouble is reported from any railroad with the butt weld of the syphon to the crown sheet. The lap weld, however, does give trouble from fire cracking. This is due to the double thickness of metal at this point and the additional metal which is applied in welding the syphon to the crown sheet, as this metal is applied on both water and fire sides of the crown sheet and syphon. These cracks should not be disturbed until leaks occur from them, then they should be cut out with a tape chisel or diamond point and welded. This method is very satisfactory in some districts, whereas in other districts it is only temporary. In cases where it is unsatisfactory, the syphon should be removed, this to be judged and handled the same as any other repairs to the firebox, bearing in mind that either the repairs or removal of a syphon is done in a safe and satisfactory manner. We find that the locomotives which had syphons applied with the corrugation of the diaphragm plate on the fire side of the firebox and welded to the syphon neck give more trouble from cracking than the locomotives which have the corrugation dished into the water side and welded on the fire side of the syphon neck only.

The latest reports indicate that there are 15,155 syphons on 6917 locomotives in use on 158 railroads. Maintenance is not exceptionally heavy except under severe conditions, the cost of maintenance being proportionately less than on other devices of equal importance.

Fig. 3.—Tool for removing scale from syphon necks

Water Treatment for Boilers

Q.—I am interested in getting some information on water treatment for boilers and would greatly appreciate it if you would furnish me with the names of some authors and publishers of texts on this subject. —R. C. K.

A.—A recent book on the treating of boiler feed water is "Boiler Feed and Boiler Water Softening" by H. K. Blanning and A. D. Rich, published by Nickerson and Collins Company, Chicago. While this book does not deal with locomotive boilers in particular, it does cover the subject of water treatment for boilers in a practical way.

Articles on the subject of water treatment for locomotive boilers can be obtained as follows: (1) "Boiler Feed Water," by J. V. Cardello, The Baldwin Locomotive, January, 1933, Baldwin Locomotive Company, Philadelphia.

(2) "Water Treatment for Locomotive Boilers," report of A.R.E.A. Committee on Water Service and San-

itation pertaining to good practice in the treatment of feed water for locomotives, THE BOILER MAKER, August, 1932.

(3) "Advantages and Disadvantages of Treated Water," Official Proceedings of the Master Boiler Makers Association, 1922, and later years, published in THE BOILER MAKER.

Calculating Unstayed Flat Heads

Q.—I will appreciate it very much if you will print as soon as possible the formula shown on page 20 for flat heads, Par. U-39 of the 1934 edition of the A. S. M. E. Unfired Pressure Vessel Code as worked out in THE BOILER MAKER. Also, will you please show the transposition of the formula to obtain D, C, P and S values. W. M. G.

A.—The formula shown on Page 20, for flat heads, Paragraph U-39 of the 1934 Edition of the A.S.M.E. Code for Unfired Pressure Vessels is as follows:

U-39 (a). The minimum required thickness of unstayed flat heads, cover plates, blind flanges, etc., shall be calculated by the following formulae:

$$t = d\sqrt{\frac{C \times P}{S}}$$

where:

t = minimum required thickness of plate, inches.

d = diameter, or shortest span, measured as indicated in Fig. U-2, inches.

P = maximum allowable working pressure, pounds per square inch.

S = maximum allowable unit working stress, as given in Table U-3, pounds per square inch.

C = 0.162 for plates rigidly riveted or bolted to shells, flanges or side plates, as shown in Fig. U-2a, and for integral flat heads as shown in Fig. U-2b, where dimension d does not exceed 24 inches and the ratio of thickness of the head to dimension d is at least equal to or greater than 0.05.

C = 0.25 for heads forged integral with or butt-welded to shells or pipes as shown in Fig. U-2d and U-2e, where the corner radius on the inside is not less than 3 times the thickness of the flange immediately adjacent thereto.

C = 0.30 for flanged plates attached to shells or pipes by means of lap joints as shown in Fig. U-2c and where the corner radius on the inside is not less than 3 times the thickness of the flange immediately adjacent thereto.

C = 0.50 for plates fusion-welded to the inside of vessels and otherwise meeting the requirements for the respective types of fusion-welded vessels, including stress relieving when required for the vessel but omitting radiograph examination, and where plate is welded for its entire thickness as shown in Fig. U-2f with a fillet weld having a throat not less than 1.25 times the thickness of the shell or flat head, whichever is the smaller.

$$C = 0.30 + \frac{1.40 \times W \times h_G}{H \times d}$$ for plates bolted to shells, flanges or side plates in such a manner that the setting of the bolts tends to dish the plate and where the pressure is on the same side of the plate as the bolting flange, as shown in Figs. U-2g and U-2h.

W = total bolt load, pounds.

h_G = radial distance from the bolt circle diameter to the diameter d, inches.

H = total hydrostatic end force on area bounded by the outside diameter of the gasket or contact surface, pounds.

d = as defined above.

Solving the formula, $t = d\sqrt{\frac{C \times P}{S}}$, for d we have:

(1) Square each side of the equation and

$$t^2 = \frac{d^2 \times C \times P}{S}$$

(2) Multiply each side of the equation by S

$$t^2 \times S = \frac{d^2 \times C \times P \times S}{S}$$

(3) Cancel out S and

$$t^2 \times S = d^2 \times C \times P$$

(4) Divide each side of the equation by $C \times P$ and

$$\frac{t^2 \times S}{C \times P} = \frac{d^2 \times C \times P}{C \times P}$$

(5) Cancel out $C \times P$ and

$$\frac{t^2 \times S}{C \times P} = d^2$$

(6) Take the square root and

$$\sqrt{\frac{t^2 \times S}{C \times P}} = d$$

Solving for C we have:

$$t = d\sqrt{\frac{C \times P}{S}}$$

(1) Square each side of the equation and

$$t^2 = \frac{d^2 \times C \times P}{S}$$

(2) Multiply each side of the equation by S

$$t^2 \times S = \frac{d^2 \times C \times P \times S}{S}$$

(3) Cancel out S and

$$t^2 \times S = d^2 \times C \times P$$

(4) Divide by $d^2 \times P$ and we have

$$\frac{t^2 \times S}{d^2 \times P} = \frac{d^2 \times C \times P}{d^2 \times P}$$

(5) Cancel out $d^2 \times P$ and

$$\frac{t^2 \times S}{d^2 \times P} = C$$

Solving in like manner for P, we have:

$$P = \frac{S \times t^2}{d^2 \times C}$$

Solving for S we have:

$$t = d\sqrt{\frac{C \times P}{S}}$$

(1) Square each side of the equation and

$$t^2 = \frac{d^2 \times C \times P}{S}$$

(2) Multiply each side of the equation by S and

$$S \times t^2 = \frac{d^2 \times C \times P \times S}{S}$$

(3) Cancel out S and

$$S \times t^2 = d^2 \times C \times P$$

(4) Divide each side of the equation by t^2

$$\frac{S \times t^2}{t^2} = \frac{d^2 \times C \times P}{t^2}$$

(5) Cancel out t^2 and we have

$$S = \frac{d^2 \times C \times P}{t^2}$$

BETHLEHEM REPRESENTATIVE IN ADVERTISERS' ASSOCIATION.—John C. Long, manager of publications, Bethlehem Steel Company, Bethlehem, Pa., will represent the Bethlehem Company in the Association of National Advertisers, New York, to which the Bethlehem Company has been elected to membership.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—John M. Hall, Washington, D. C.
Assistant Chief Inspector—J. A. Shirley, Washington.
Assistant Chief Inspector—J. B. Brown, Washington.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Director—Joseph B. Weaver, Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—D. S. Jacobus, New York.
Acting Secretary—M. Jurist, 29 W. 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

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Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.
Vice-Chairman—F. A. Page, San Francisco, Cal.
Statistician—L. C. Peal, Nashville, Tenn.

International Brotherhood of Boiler Makers, Welders, Iron Ship Builders and Helpers of America

International President—J. A. Franklin, Suite 522, Brotherhood Block, Kansas City, Kansas.
Assistant International President—J. N. Davis, Suite 522, Brotherhood Block, Kansas City, Kansas.
International Secretary-Treasurer—Chas. F. Scott, Suite 506, Brotherhood Block, Kansas City, Kansas.
Editor-Manager of Journal—L. A. Freeman, Suite 524, Brotherhood Block, Kansas City, Kansas.
International Vice-Presidents—Joseph Reed, 3753 S. E. Madison Street, Portland, Ore.; W. A. Calvin, Room 402, A. F. of L. Building, Washington, D. C.; Harry Nicholas, 6215 S. Benton Blvd., Kansas City, Mo.; W. E. Walter, 637 N. 25th Street, East St. Louis, Ill.; J. H. Gutridge, 2178 South 79th Street, W. Allis, Wis.; W. G. Pendergast, 1814 Eighth Avenue, Brooklyn, N. Y.; W. J. Coyle, 424 Third Avenue, Verdun, Montreal, Quebec, Can.; A. M. Milligan, 262 Trent Avenue, East Kildonan, Man., Can.; J. F. Schmitt, 28 S. Roys Street, Columbus, Ohio; William Williams, 1615 S. E. 27th Avenue, Portland, Ore.

Master Boiler Makers' Association

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First Vice-President: Franklin T. Litz, foreman boiler maker, C. M. St. P. & P. R. R., Dubuque, Ia.
Second Vice-President: Ira J. Pool, field service representative, National Tube Company, 5610 Merville Avenue, Baltimore, Md.
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Fifth Vice-President: Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis (Big Four), 814 Big Four Building, Indianapolis, Ind.
Secretary: Albert F. Stiglmeier, general foreman boiler maker, New York Central, West Albany Shops, 29 Parkwood Street, Albany, N. Y.
Treasurer: William H. Laughridge, retired general boiler inspector, Hocking Valley R. R., 537 Linwood Avenue, Columbus, O.
Executive Board—Chairman: J. L. Callahan, general boiler inspector, Chicago Great Western, Oelwein, Ia.

American Boiler Manufacturers' Association

President—Owsley Brown, Springfield Boiler Company, Springfield, Ill.
Vice-President—S. H. Barnum, The Bigelow Company, New Haven, Conn.
Secretary-Treasurer—A. C. Baker, 709 Rockefeller Building, Cleveland.
Executive Committee (Three years)—Walter F. Keenan, Jr., Foster Wheeler Corporation, New York. E. E. Knobloch, Union Iron Works, Erie, Pa. C. W. Miller, E. Keeler Boiler Company, Williamsport, Pa. A. G. Weigel, Combustion Engineering Corporation, New York. (Two years)—F. H. Daniels, Riley Stoker Corporation, Worcester, Mass. M. E. Finck, Murray Iron Works, Burlington, Ia. A. G. Pratt, Babcock & Wilcox Company, New York. (One year)—A. W. Strong, Strong-Scott Manufacturing Company, Minneapolis. R. B. Mildon, Westinghouse Electric & Manufacturing Company, Philadelphia, Pa. R. B. Dickson, Kewanee Boiler Corporation, Kewanee, Ill. (Ex-Officio)—Owsley Brown, Springfield Boiler Company, Springfield, Ill. S. H. Barnum, The Bigelow Company, New Haven, Conn.

OFFICE OF INDUSTRIAL RECOVERY COMMITTEE, 15 PARK ROW, NEW YORK

Manager—James D. Andrew.
Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President — Merle J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

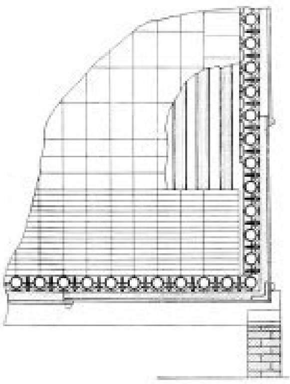
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,900,006. FURNACE. ERVIN G. BAILEY, OF CLEVELAND HEIGHTS, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO FULLER LEHIGH COMPANY, A CORPORATION OF DELAWARE.

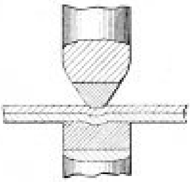
Claim.—A furnace wall composed of parallel tubes combined with tiles



or blocks, each block having at the ends of its rear portion concave seats adapted to fit the outer surfaces of a pair of tubes, and each having conductive cement material between the tubes and tile affording a gas-tight heat-conducting union between the tubes and tile, and means for securing the tiles to the tubes under pressure. Twenty-four claims.

1,900,161. SPOT WELDING. MORRIS J. COHAN, OF BROOKLYN, NEW YORK.

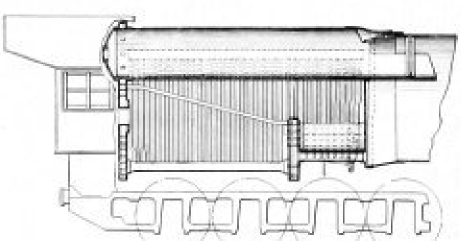
Claim.—That process of spot welding a pair of superposed contacting work pieces by pressing the work sheets together at a definite locality and passing through the locality from one piece to the other an electrical



current of sufficient amperage and for a sufficient time to weld the contacting portions together at the spot, which is characterized by the step of forming, simultaneous with the welding, a protrusion on one of the work pieces of such dimensions that contraction during cooling will render the surface of the metal protruded coplanar with the surrounding metal. Two claims.

1,909,874. WATER TUBE FIRE BOX LOCOMOTIVE BOILER. HARRY L. LUERS, OF BALTIMORE, MARYLAND.

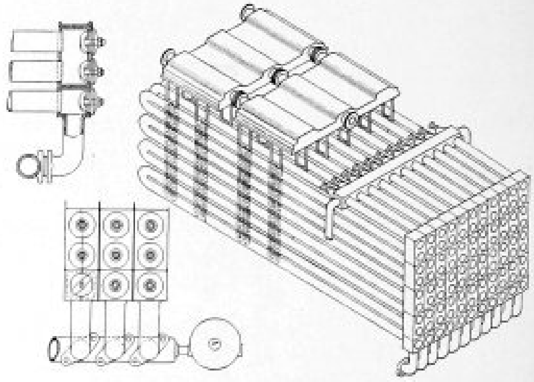
Claim.—In a locomotive water tube firebox boiler, a door sheet, a throat sheet, a rear flue sheet, a main combustion chamber between the door sheet and throat sheet, water circulating and steam generating means at



the top of the firebox, a hollow flow connection of substantially U-shaped cross-section between the rear flue sheet and the throat sheet and forming therewith an auxiliary combustion chamber, and water tubes at the sides of the auxiliary combustion chamber connecting said water circulating and steam generating means with said U-shaped connection. Eleven claims.

1,874,236. HIGH PRESSURE LOCOMOTIVE. ALFRED W. BRUCE, OF NEW YORK, N. Y.

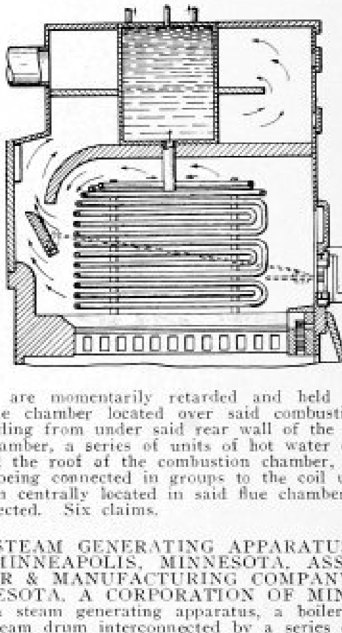
Claim.—In a locomotive, the combination of a steam generator having longitudinal upper drums for the collection of steam; longitudinal lower drums for water, longitudinal banks of tubes establishing communication



between the upper and the lower drums, and a fire chamber between the banks of tubes, and an economizer disposed forwardly of the generator and embodying a plurality of spaced water tubes, said spaces being open to the fire chamber to adapt them for the reception of products of combustion from said fire chamber. Twenty-nine claims.

1,904,179. HOT WATER HEATING FURNACE. CARL A. W. VOIGT, OF PORTLAND, OREGON.

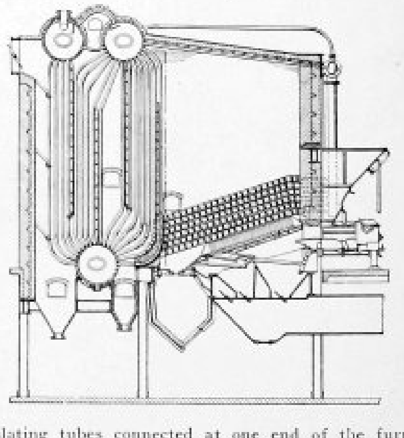
Claim.—In a hot water heating apparatus, a combustion chamber provided with a dome-like roof and a rear wall extending to a point relatively close to the bottom of the combustion chamber, whereby the products



of combustion are momentarily retarded and held in said combustion chamber, a flue chamber located over said combustion chamber and a passageway leading from under said rear wall of the combustion chamber to said flue chamber, a series of units of hot water coils arranged along three sides and the roof of the combustion chamber, the return pipes of the apparatus being connected in groups to the coil units, respectively, a hot water drum centrally located in said flue chamber to which said coil units are connected. Six claims.

1,909,091. STEAM GENERATING APPARATUS. CHESTER W. BROS, OF MINNEAPOLIS, MINNESOTA, ASSIGNOR TO WM. BROS BOILER & MANUFACTURING COMPANY, OF MINNEAPOLIS, MINNESOTA, A CORPORATION OF MINNESOTA.

Claim.—In a steam generating apparatus, a boiler comprising a mud drum and a steam drum interconnected by a series of water circulating tubes, a furnace substantially horizontally alined with said boiler, groups



of water circulating tubes connected at one end of the furnace with the mud drum of the boiler and at the opposite end of the furnace with suitable upright headers, a horizontal header connected with said upright headers, and an upper group of water circulating tubes arranged adjacent to the upper wall of the furnace within the combustion chamber and connecting said horizontally disposed header with said steam drum, whereby a portion of the water in said boiler will circulate through said upper group of tubes to thereby cool the upper wall of the furnace. Five claims.

Boiler Maker and Plate Fabricator

Boiler and Heavy Plate Industry Gains Continue

Although the season is rather early for very accurate forecasting in regard to the boiler and heavy plate industry, the boiler manufacturers report steadiness in that quarter and the plate fabricators seem to be enjoying a mild boom with excellent prospects of even more business.

Orders for new steel boilers in January 1936 were 639 units, as compared with 595 for December and 329 for January a year ago. The amount of heating surface contracted for showed a 7 percent decline, however, indicating that business in the smaller heating boiler field has strengthened somewhat, which condition is due no doubt, to the severe winter. Power boiler orders fell off about 12 percent but this was offset by a 20 percent increase in heating boiler production.

The fabricated steel industry reached a point in January last, unequaled in any month in the past two years, with a total of 38,709 tons on order. Oil storage tanks and refinery equipment and material showed generous gains for the month, while tank cars, gas holders and blast furnaces made a new monthly high, with a total of 4528 tons ordered. Miscellaneous items aggregated 28,236 tons, revealing the largest monthly business since March, 1934.

Rules for Welding Repairs

In the interest of safety and to promote uniformity in the repair of boilers and pressure vessels, the National Board of Boiler and Pressure Vessel Inspectors has issued new rules governing the use of fusion welding in this type of work. The previous rules issued by the National Board three years ago, of necessity required revision to make them conform with developments in the welding art, as well as to the standards now acceptable in new construction.

Co-operating in the preparation of the regulations with the National Board, the Engineers' Conference of the Boiler and Machinery Department of the National Bureau of Casualty and Surety Underwriters aided tremendously in formulating this practical working code, which will remove much of the uncertainty surrounding the acceptability of certain repair work in which dependence is placed on welding. The rules as finally issued conform fully with A.S.M.E. Boiler Code requirements and have the entire approval of the Boiler Code Committee.

The philosophy behind every planned step of the National Board since its inception as contained in the preamble to its constitution is to "promote greater safety to life and property by securing concerted action and maintaining uniformity in the construction, installation and inspection of steam boilers and other pressure vessels and their appurtenances."

While the present contribution to this fine objective is brief, the welding repair rules as published elsewhere in this issue, contain every essential requirement for adequate protection of life and property when properly carried out. The aim for securing uniformity of application of the rules is assured of achievement by the great body of National Board inspectors throughout, the country as well as by the insurance inspectors, the interests of whose companies have been so well served through their co-operation with the National Board.

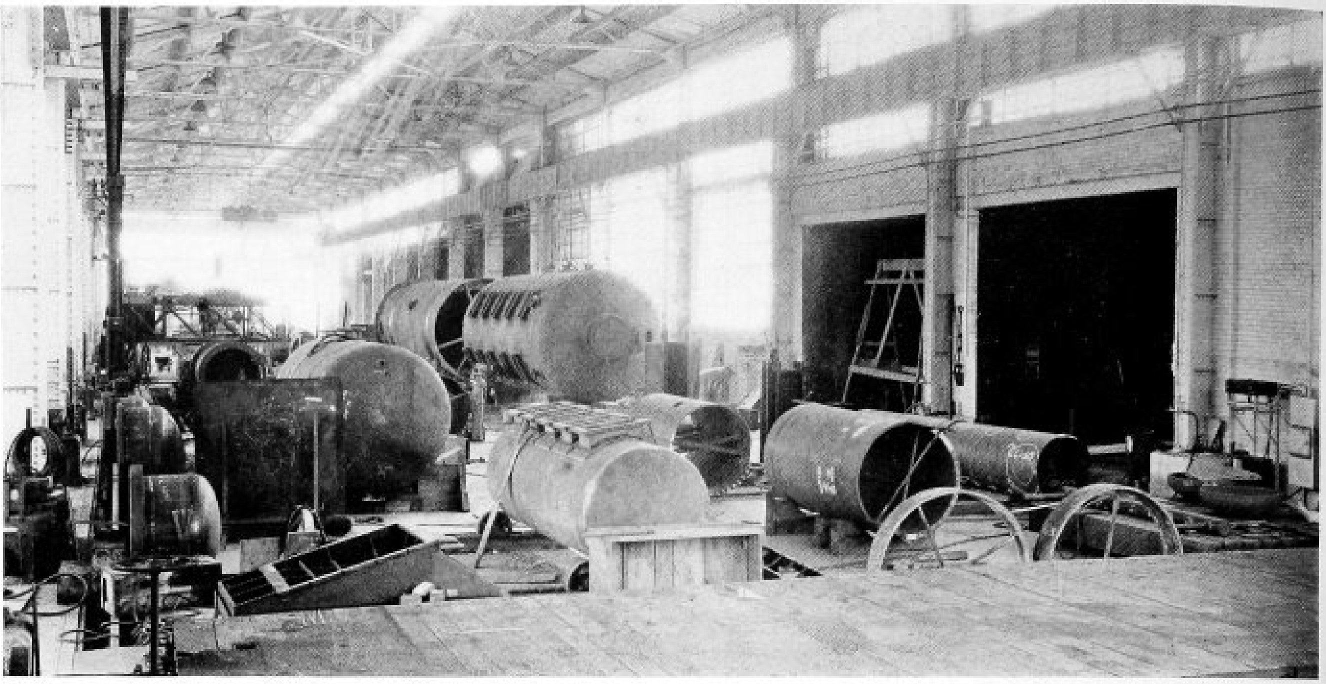
The manufacturers of boilers and firms having the task of carrying out repairs to boilers and pressure vessels will gain a real advantage from this complete understanding of the requirements to which they must conform.

Locomotive and Car Orders Show Increases

More orders were placed for the construction of steam locomotives for domestic service during January and February than the entire twelve month period of 1935. Approximately 60 percent as many steam locomotives have already been ordered this year as the entire locomotive orders for 1935. During the past two months orders for 50 steam locomotives were placed as compared with one for the same period last year and 28 for the entire year. In addition, five steam locomotives are being built for foreign interests and plans are being drawn up for 20 to 25 more units. The January and February totals, for all types of locomotives, amounted to 60, as compared with 83 ordered last year for domestic use.

The first nine months of the present year reveal 8286 freight cars ordered as compared with 830 ordered in the same period last year. Further substantial buying is in prospect as inquiries are outstanding for 1300 more and plans are under way for 3800 others.

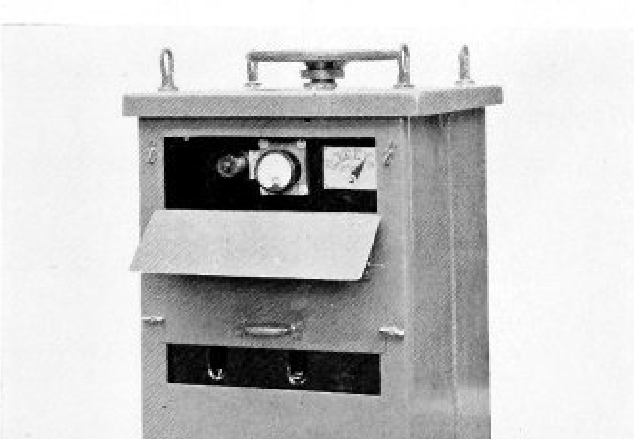
Passenger car and streamline train construction also shows similar gains and the outlook appears to be extremely bright for the heavy industries in the railway equipment field.



General view of welding shop, Foster-Wheeler plant at Carteret, N. J.

Alternating-Current Arc Welding

Pressure Vessel Applications



G-E welding transformer, 500-ampere type

By O. A. Tilton* and J. T. Phillips†

Alternating-current arc welding seems to be a subject that draws a great deal of comment in these times, and it is being so frequently discussed that we run the risk of becoming monotonous when we endeavor to devote an article to its consideration. One reason which may justify devoting this time to it is that there appears to be many conflicting or at least fragmentary conceptions of the various factors involved. If we can correlate these in their correct proportions then perhaps something will have been accomplished. We would also like to present our experience in the application of alternating current in production work, which has now been in actual operation over a year.

The fact that alternating current has finally taken an important part in welding is due to two things.

1. Improvement in the quality of weld metal obtainable with heavily coated electrodes has created a demand for these electrodes for almost universal use and their consequent production at reasonable cost. Heavily coated electrodes are almost essential in the alternating-current process.

* Industrial Engineering Department, General Electric Company, Schenectady, N. Y.

† Superintendent Boiler Department, Foster Wheeler Corporation, Carteret, N. J.

2. An important characteristic of alternating current is, the practical elimination of magnetic blow. In many cases, this adds materially to quality and reduces cost of welds.

The most important factors in deciding whether to apply the alternating-current process are:

1. Whether the practical elimination of magnetic blow would be of great benefit.

2. Whether the relatively poorer penetration of alternating current as against direct current in the lower ranges of welding currents would be of any advantage or disadvantage. (The question of penetration will be discussed later.)

There are other advantages of minor importance and some disadvantages but it may be considered as a general principle of application that these two questions should be answered before going further with the application.

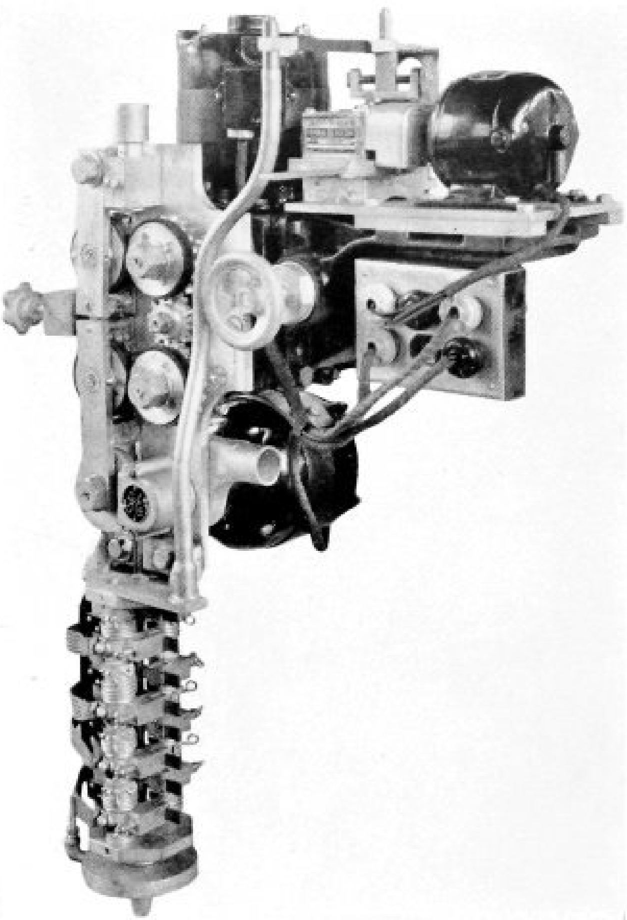
Somewhat of a theoretical explanation of the phenomena encountered with alternating-current welding will help to clarify its position.

In an arc made with bare steel electrodes, when direct current is used, the distribution of heat in the arc is on the order of 60 percent at the positive terminal and 40 percent at the negative. This ratio is variable, due to the effect of various fluxing ingredients that may be applied in the form of coatings on the electrodes. The very fact of an uneven distribution of heat in the direct-current arc is made use of in "straight" or "reversed polarity" welding to obtain the desired penetration, particularly on low-current values. It is obvious that the average distribution of heat between electrode and work becomes equal when alternating current is used, which explains the fact that fundamentally, alternating current has less penetration than direct current. This may also be carried further to explain why the weld metal becomes more fluid in the alternating-current arc than when direct current is used.

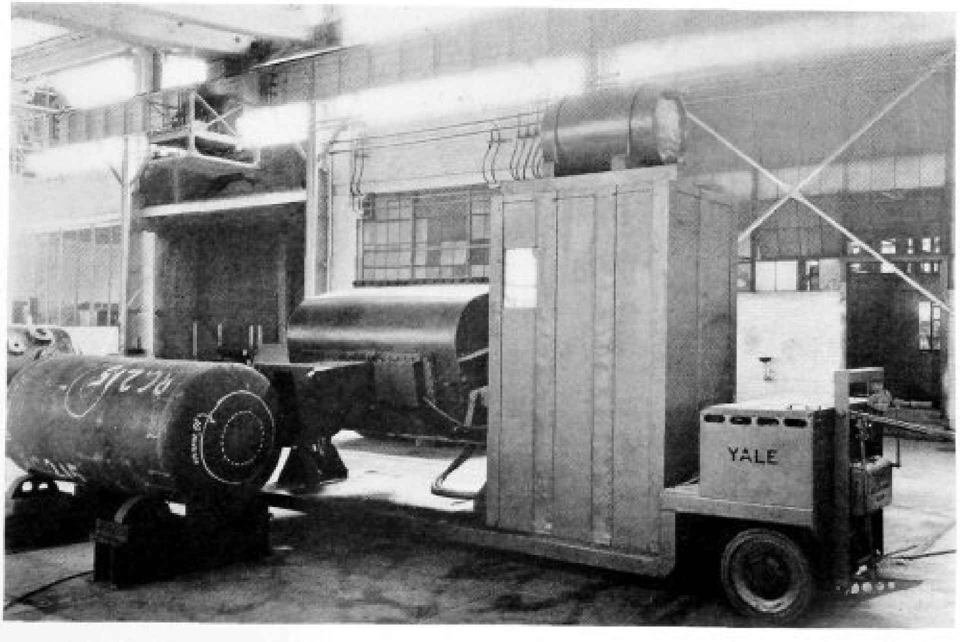
When we talk of penetration, which is caused mainly by the degree of heat applied, it is also obvious that as current values increase, there is so much heat involved that variation in penetration becomes less and less, until finally it is negligible. Experiments seem to indicate that above 250 amperes, the relative penetration with direct current or alternating current is practically equal.

Up to this point, we have considered only penetration and the use of bare steel electrodes. There is another relative factor in the two processes of welding which is of importance, namely, stability of the arc, which it will be shown governs the type of electrode and equipment that is to be used.

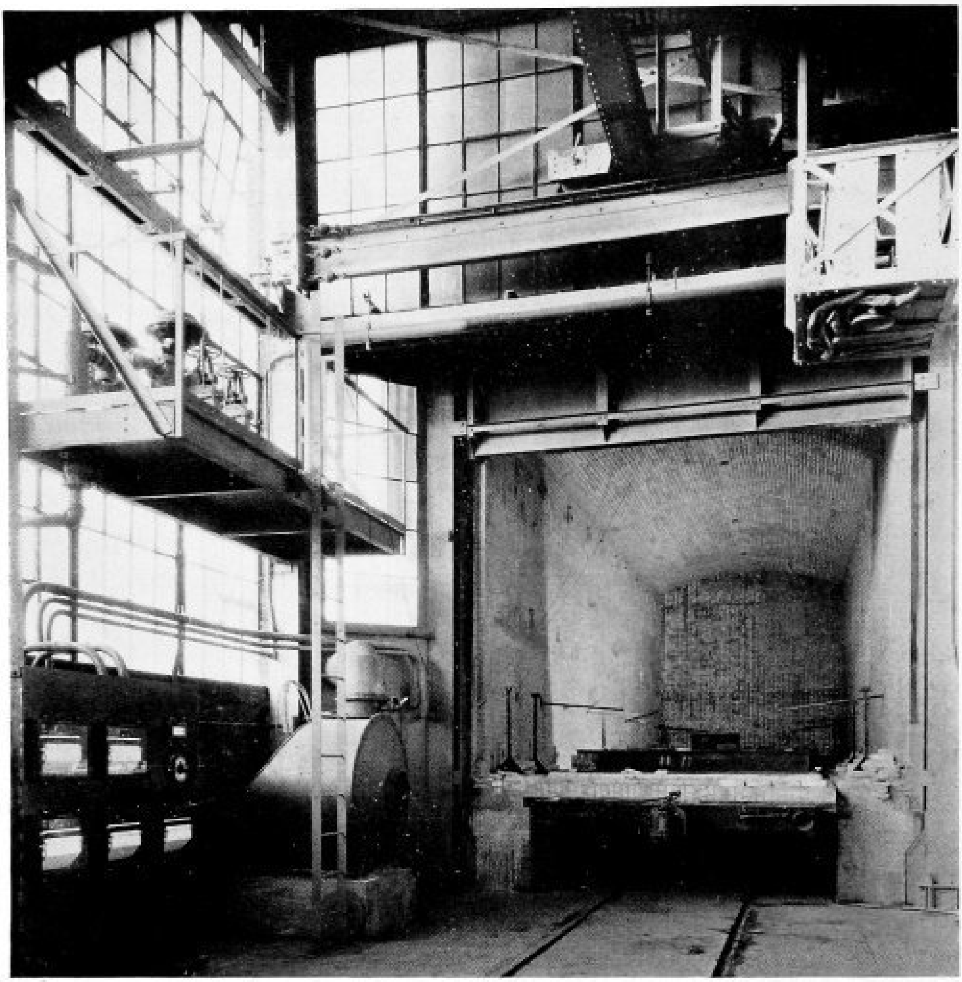
The word stability as used herein refers principally to the maintenance of the arc without extinction.



Automatic arc-welding head with oscillator



Inspection of arc-welded pressure vessel, by means of latest portable type X-ray equipment



Stress relief annealing of welded construction is carried out in a special butane-fired annealing furnace

In either process, after the arc is struck, the ionization of the gap between the electrode and the work reduces its resistance and permits the flow of current until or unless something occurs to upset this condition. Assuming the arc length to be held constant, the steady flow of direct current maintains its stability. In the alternating-current process the reversal of current each half cycle upsets the stability of the arc and, therefore, unless something is done to prevent it, the arc goes out. This something may be the superposition of a pilot or igniting circuit, the use of a heavily coated electrode which shields the arc and stabilizes it, the use of heavy currents involving so much heat as to be inherently stable, or the use of abnormally high open-circuit voltages.

Experiments have proved that superimposed pilot or ignition circuits are almost mandatory when using current values of less than 100 amperes alternating current with any electrode, unless undesirably high open-circuit voltages are used, in which case it is still impossible to weld readily at less than about 60 amperes.

With alternating-current values of from 100 to 200 amperes, the superimposed pilot circuit is not necessary if the stabilizing effect of heavily coated electrodes is applied.

When using more than 200 amperes of alternating current the arc is sufficiently stable because of the heat involved, so that no additional stabilization is necessary and, therefore, almost any kind of electrode may be used.

Experience in welding as a whole has shown that high quality weld metal requires the use of heavily coated electrodes. But not every such electrode operates satisfactorily with alternating current. Therefore, specially designed heavily coated electrodes are necessary for good welding with alternating current in any current values. These electrodes are usually successful with direct current too, but the arcing characteristics vary between the two processes. For instance, electrode "A" produces Class 1 welds in any position with alternating current, but when used with direct current at reversed polarity, the weld metal becomes so fluid that it can be used only in the down-hand or flat position.

The alternating-current arc welding transformer is a highly efficient unit, its efficiency at full load being 85 or 90 percent against 60 percent for the direct-current welding motor-generator set. Also, at no load, the transformer losses are only 1.5 to 2.8 percent as against about 20 percent for a direct current set. Therefore, ignoring power-factor, the power consumption can be reduced at least 25 to 30 percent by the use of alternating current.

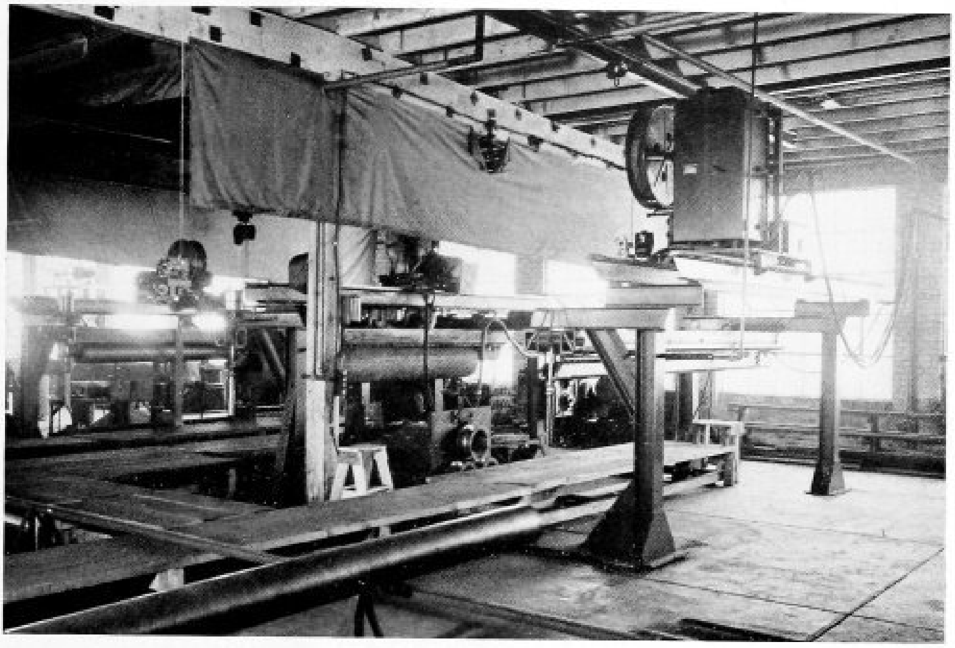
Running gear can be added to an arc-welding transformer unit, making it portable. For all practical purposes, however it seems that this should be limited to shop portability. There are several reasons for this:

1. The most advantageous applications of alternating current seem to be shop production jobs.

2. The usual out-of-door application requiring transportation of equipment from place to place, is essentially a hand welding job, involving currents in the medium and low ranges, at which it has been shown that direct current gives the best overall results.

3. Welding leads on alternating-current units should

Full automatic arc-welding equipment using heavily coated electrodes with alternating-current welding transformers is pictured



be limited to about 100 feet unless special types of leads are used, because of the inductive voltage drop involved, whereas direct current units operate satisfactorily with leads as long as 500 feet.

4. Transformer arc-welding units are drip proof but are not usually made weatherproof.

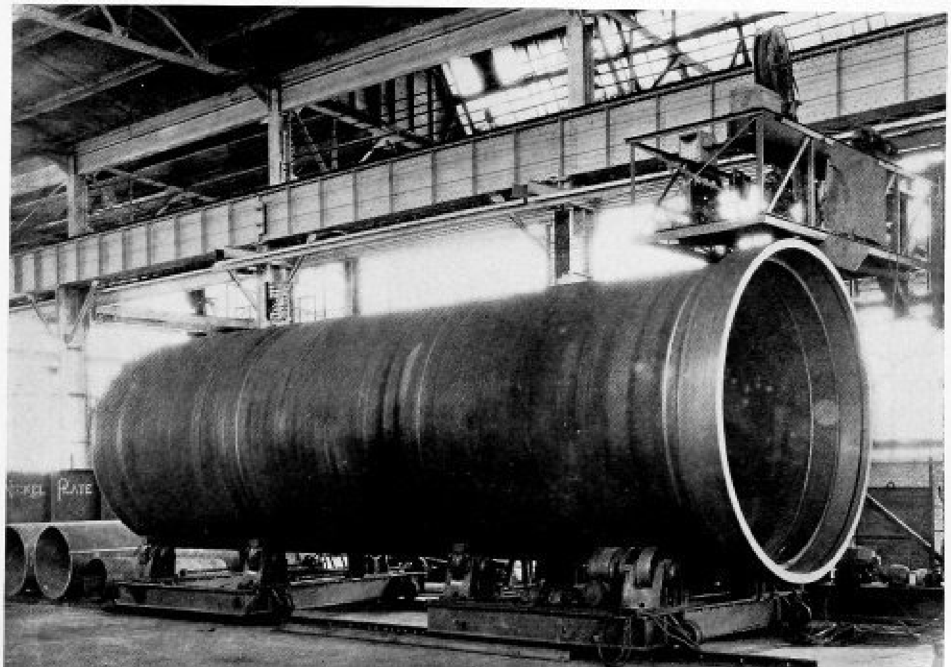
5. Alternating-current power lines are frequently not available for other than shop installations.

High-frequency arc welding is a term used to distinguish welding with a main power supply at frequencies higher than 60 cycles, as against the superimposed high-frequency pilot circuit on units of 60 cycles and lower frequencies.

Tests have been made with various frequencies, from 25 to 420 cycles to determine whether increase in frequency accomplishes any improvement in welding. It has been found that frequencies higher than 60 cycles show no advantage. It is, of course, possible that 1000 cycles or higher might be of some advantage, but their use is not practical because inductive voltage drop in the leads increases directly with frequency, and the cost of equipment becomes prohibitive.

The typical 500-ampere alternating-current arc-welding unit illustrated, is a high-reactance, air-cooled transformer. Primary windings of the 220/440-volt units are in two sections for series-parallel connection for either voltage. Secondary windings are tapped for two nominal secondary voltage values, 80 volts and 100 volts. The unit is enclosed in a readily removable welded-steel, drip-proof housing, furnished with lifting eyes at the

Arc-welded evaporator shell, 40 feet long; 10 feet in diameter, fabricated to A. S. M. E. Code requirements



top and steel doors over terminals and instrument panel.

On the top is a hand wheel for current adjustment, properly marked to indicate direction of rotation. At the top of the front is an instrument panel, mounting a combination voltmeter and ammeter, a selector switch for the same and an indicating dial for the approximate current setting of the unit. Below the panel is the secondary terminal board, with connecting studs and links for tap changing. Welding leads may be brought to the studs on the panel through specially formed openings which avoid abrasion of the conductor insulation. On the rear side, near the top, is the primary connecting panel, with studs and links for voltage changing. The opening over this panel is covered by a hinged door, which is fitted with hasp and staple for padlocking.

The most popular size of arc-welding transformer is the 500-ampere unit, with the 750-ampere size next, and the 1000-ampere size used for special, heavy-current applications. The 150-ampere size applies to a very special field of alloy and light sheet-steel work. The applications discussed herein apply to 500-ampere and larger units.

Applications have been made of both hand and automatic welding. Production work involving one or more of the following special features, justifies the use of alternating current.

1. Practical elimination of magnetic blow of special importance.

2. High quality welds such as Class 1 or Class 2 of the A. S. M. E. Boiler Code required on such thicknesses of material that multiple bead welds will be used.

3. Single-pass welds on light material requiring less than 100 percent penetration and quality about equal to Class 3 of the A. S. M. E. Code.

4. Heavy-current high-speed automatic or hand welding irrespective of quality or penetration.

5. Power lines of commercial voltage and frequency readily available within about 100 feet of the work.

The question is frequently asked as to how alternating current operates for carbon-arc cutting. Although this work can be accomplished with alternating current, the results are not as successful as when direct current is used. Cutting speeds with direct current are approximately 90 percent faster than with alternating current. It is believed that this may be because of the unequal distribution of heat available in the direct-current arc and the unidirectional magnetic blow which assists in removing the molten metal more rapidly.

Another question is as to whether alternating current can be used with satisfactory results on nonferrous alloy welding. Up to the present time no satisfactory procedure and electrodes have been developed for using alternating current on this application.

Special control devices of an automatic nature are available. These are intended to reduce to a minimum the possibility of a man receiving a shock from the secondary or welding leads of transformer units. Thorough investigation has not disclosed data to prove that such a shock would be any more than annoying to a man in a reasonably good physical condition. The standard transformer units, therefore, do not include any of these special control devices.

In 1934, the Foster Wheeler Corporation, dismantled the foundry at their Carteret, N. J. plant, in order to convert it into a weld-fabricating shop. Although this foundry was only 10 years old and, at the time of its erection, was the largest in the Metropolitan area, the rapid advance of the welding art had practically eliminated the utility of this foundry. They completely equipped this shop for the manufacture of pressure vessels under the Class 1 requirements of Par. U-68 of the A. S. M. E. Code.

The illustration on page 54 gives an idea of the size and general layout of the shop. At the left is another bay of about the same size as the one shown and at the right is an ell used largely for material preparation.

A thorough investigation of both the alternating-current and the direct-current process and the relative merits of automatic and hand welding led to the decision to adopt automatic alternating-current welding. The basis of this decision has already been explained in detail. Now, after 1½ years of operation on regular production, it may be stated that all the expected advantages of the alternating-current process have been realized and complete statistics also exist which justify the use that is made of the automatic method of welding.

The shop features two automatic welding machines, which also are illustrated. Each consists of a traveling jib-crane-like structure, on the bridge of which is mounted the automatic welding head and its control. These units are entirely motorized, that is, the entire structure travels longitudinally along rails located at the side, one at the top and the other at the bottom, and the bridge may be raised or lowered to accommodate shells up to a maximum diameter of 14 feet. These two machines are placed end to end and in this manner they can be used separately on some of the shorter vessels or together they will handle a maximum length of 90 feet.

The cars on which the work is held, include motor-driven rollers so synchronized that a vessel may be rotated at a uniform speed for the welding of circumferential seams. Of course the longitudinal seams are made by traversing the head along the stationary vessel.

The automatic welding head with which each is equipped is a device which feeds a heavily coated electrode continuously from a reel, cutting a narrow slot through the coating so that metallic brushes conduct the welding current to the steel core of the electrode. Electrical control of the rate of feed of the electrode automatically maintains a uniform arc length.

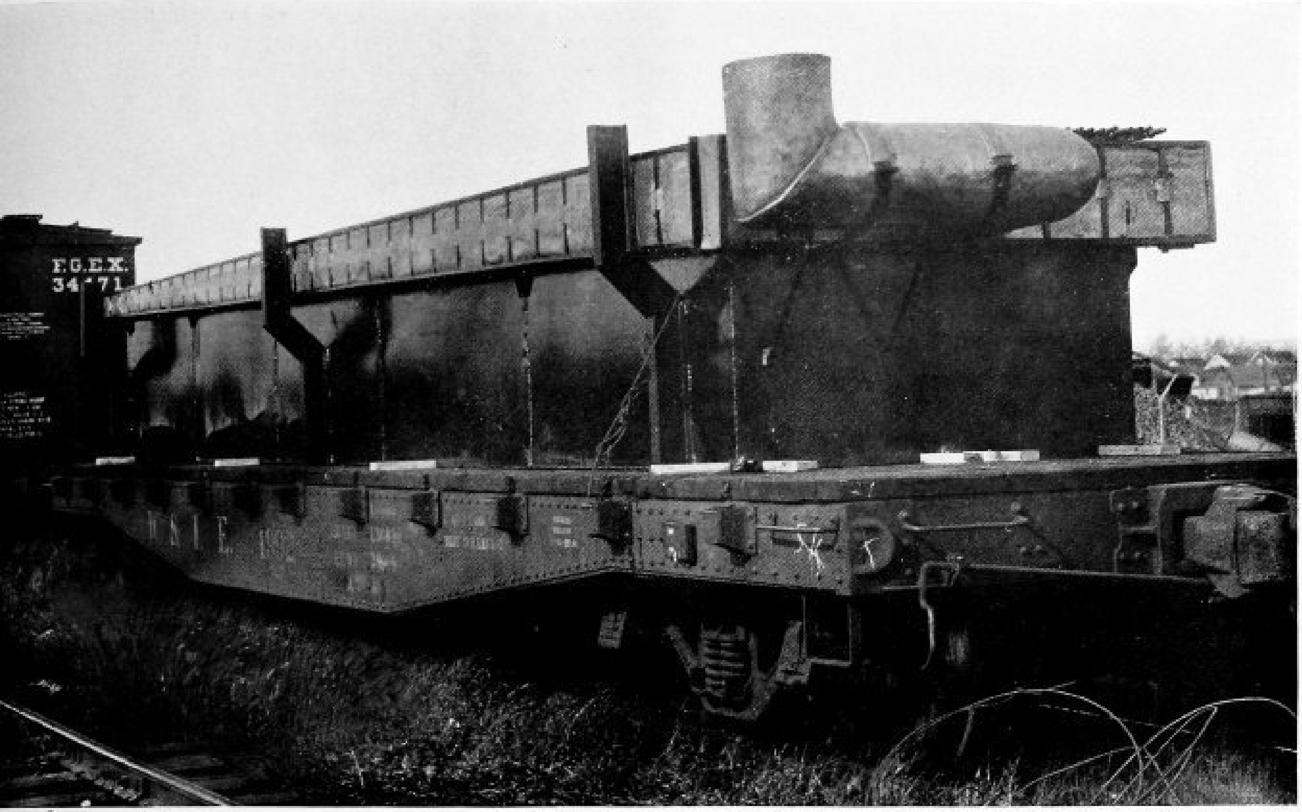
In this class of work, nearly all vessels are examined by X-ray. Portable X-ray equipment set in position for photographing the circumferential welded seam between head and shell of a pressure vessel is shown. This machine is equipped with a 300,000-volt tube, which is the most powerful unit now in use and is capable of examining steel plates up to 4 inches thickness.

Stress relief annealing is applied to work of this kind in a special furnace equipped with temperature recording instruments and temperature control devices. Vessels are brought up to 1200 degrees F. at the rate of 400 degrees per hour, held at that temperature for 1 hour per inch of maximum thickness and cooled in the furnace at the rate of 150 degrees per hour to 500 degrees and then cooled in air.

One of the largest units that has so far been produced with this equipment is illustrated on page 57. It is shown set up on the motor-driven rollers and with the bridge of the automatic welder set in place for the circumferential seam between the flange and the shell. This vessel was 35 feet long and 10 feet in diameter, with a plate thickness of 1⅜ inches.

The Foster Wheeler plant has mostly alternating-current welding equipment but also a few direct-current welding machines which are used on special applications. Preference is given to the use of alternating current at all times. There are instances when some alloy requires the use of a special electrode which has not been designed for use with alternating current. Then, the direct-current process is used. In still other instances

(Continued on page 60)

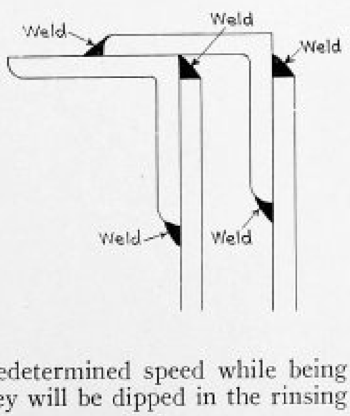


Largest electroplating tanks, fabricated by arc-welding

Fabricating a Large Plating Tank

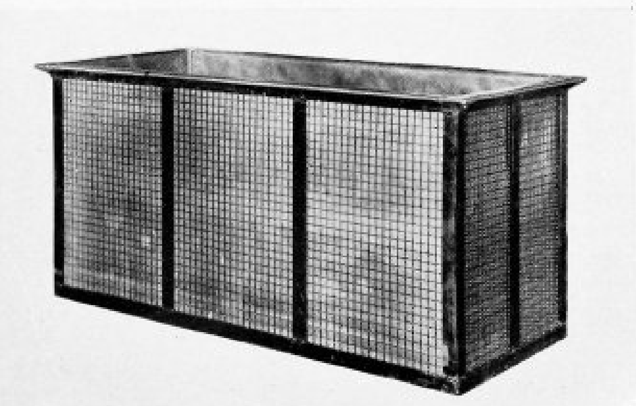
By V. D. Green*

The second of two electroplating tanks, stated to be the largest of their kind ever built, has been designed and completed by Gross Engineering Corporation, Cleveland, for an Evansville, Ind., firm. This tank is to be used in connection with the alumilite process of producing colored finishes on aluminum without the aid of paint or varnish; and will be employed for large automobile body stampings. The stampings will be handled by a conveyor placed above the tank, and will be moved slowly along the tank at a predetermined speed while being alumilited; after which they will be dipped in the rinsing tank section of the equipment and finally raised out of the way for removal from the conveyor.



Method of reinforcing top of tank with angle irons and welding

The overall dimensions of the tank are; 34 feet 4 inches long, 4 feet 2 inches deep, and 6 feet 4 inches wide. A steam-heated water jacket is provided between



Welded rinse tank

* Manager, Technical Advertising Agency, Cleveland.

inner and outer shells in order to maintain the solution at the proper working temperature.

The outer tank is composed of ¼-inch mild steel plates welded at the seams by the electric-arc process, using regular welding rods. The plates are reinforced at the top by angle irons 2 inches by 2 inches by ¼ inch thick, these angle irons being welded together all along the meeting edges. The inner tank is made of heavy-gage lead sheets burned together at the seams with an oxy-hydrogen torch, chemically pure lead burning bars being used. These sheets are supported by a backing of strong wire mesh, producing a structure of ample strength, since the pressure of the solution on the inside is counterbalanced by that of the water in the jacket on the outside.

The rinse tank, located in the middle of one side of the main tank, is 50 inches by 36 inches by 48 inches, and is made of ¼-inch welded steel plate, lead-lined on the outside where it is in contact with the solution. The heating system consists of 600 feet of 1-inch diameter lead pipe and 250 feet of ¾-inch lead pipe, situated partly in the main tank itself and partly in the water-jacket space between inner and outer shells. The piping is supported on lead-coated steel frames.

In order to leave the top of the tank clear for the operation of the conveyor and the stampings which hang therefrom, a special form of fume-removal system, (similar to that used on many chromium plating tanks), had to be used. The system consists of a slotted hood surrounding the upper part of the tank just above the level of the solution, connected to a powerful exhaust fan through a vent; thus drawing off the vapor as soon as formed, yet without obstructing the top of the tank by the usual hood structure. The hood and the vent connected to it and to the exhaust ducts are of reinforced lead and are thus corrosion proof.

Although the actual welding and leadburning present no special features apart from the size of the job on which they are used, the method of lead-coating those parts where mechanical strength plus high corrosion resistance are required is interesting. One of the principal difficulties met with in ordinary lead coating, in which the lead is merely melted over the surface of the steel or other metal it protects, is that it tends to crack, buckle or peel off, especially if, as in this case, the expansion and contraction due to heating and cooling must also be encountered, since the expansion rates of the two metals are different. The method used in the world's largest plating tank, however, is that known as the "leadhesion" process.

Parts which are small enough to be pre-treated in a tank are first cleaned by pickling in dilute sulphuric acid. They are then rinsed off and immersed in a bath of pure molten lead on the top of which floats a thick layer of flux of a formula discovered and controlled by Louis Gross, president of Gross Engineering Corporation. The action of this flux is to open up the pores of the metal to be protected; with the result that a thin flawless and permanently-adhering coat of pure lead is intimately amalgamated with the surface of the protected metal. Since this coating is pure lead, there is of course no difficulty in building up the coating to any desired thickness by regular lead burning. Tests have proved that the lead coating is thus united so firmly with the metal beneath that even a hammer and chisel can barely separate them. Expansion and contraction do not affect the bond either. Parts which are too large to be handled in a pre-treating tank can be lead coated by this process by cleaning the surface with emery wheels or sandblast, then preheating, the flux brushed on, and, as soon as the metal has reached about 700 degrees F., applying the lead coating with a burning bar. Altogether 8 tons of lead were used in the construction of this huge tank. The total weight, empty, is sixteen tons.

Alternating-Current Arc Welding

(Continued from page 58)

the desired rod performs equally as well on either process and then alternating current is always used. Experience has shown that the welders prefer alternating current, where they have the choice. This, of course, applies to hand-welding operations, as the automatic machines are used for alternating current only.

There seems to be a characteristic to the alternating-current arc which can actually be felt by the operator, making it easier to establish and hold a uniform arc than with direct current. Aside from this, it has been found that there is a greater consistency of good work with the alternating-current process, possibly due to the agitation of the molten metal caused by the alternations of current direction.

A saving in handling time results when alternating current is used, because it is not necessary to position the work. This would be very difficult with direct current because practically all electrodes that are used for high quality work with the direct current process are so fluid in the arc that positioning is almost necessary to obtain good results. This particularly applies to the heavy fillet welds used when attaching fittings to pressure vessels.

In regard to the comparison between hand and automatic welding, the experience in this plant shows some interesting figures.

On circumferential seams, once a piece has been set up on the automatic welder, the arc current and voltage and speed of rotation is established and the work is rotated continuously until the weld is completed. It is not uncommon for the arc to be continuous for as much as four hours under these conditions. The slag is cleaned from the weld surface, as the vessel is rotated, in preparation for the next layer. A saving of approximately 30 percent in the cost of the weld is accomplished by using the automatic arc on these seams.

Longitudinal seams show a smaller saving for the automatic arc, depending on the length of seam and the plate thickness. This is because of the time consumed in stopping and starting the arc at the ends of the seam and returning the travel carriage to its starting position. When these seams are less than 8 feet long there is usually no saving in the use of the automatic. When they are 8 feet or longer the savings may be from 5 to 10 percent.

As far as quality is concerned, if speed is ignored, the hand welder should produce as consistently good quality welds as the automatic. This is because he has the opportunity to manipulate the arc so as to keep the slag back from the molten pool. However it should also be stated that with this type of automatic there is a small steady blow of the arc toward the crater parallel to and opposite from the direction of travel. This also keeps the slag from choking the arc and is part of the reason for the good quality of automatic welds.

It is perhaps unnecessary to add, in conclusion, that heavily coated electrodes are used exclusively in this plant, even for tack welds. Welding operators are paid on an hourly rate basis and welders are encouraged to maintain a high production rate by a sympathetic attitude of the management, although the maintenance of a high standard of workmanship is insisted upon.

Federal Housing Administration arranges credit for

Modernizing Power Plant Equipment

Federal assistance has stimulated boiler manufacturing indirectly by the financing of loans to industries for replacing obsolete and worn-out power plants. In the present article, brief facts concerning the modernization credit plan are given, as well as examples of plant efficiency gains achieved by installing modern boilers. Boiler manufacturers can aid concerns interested in modernization by calling attention to the credit possibilities provided by the NHA

In addition to obsolescence of machinery and equipment, surveys made in factories, industrial and manufacturing plants have revealed that in some instances inefficiency was due primarily to the lack of sufficient operating power. Boilers were too small, outmoded or practically worn out from being forced for too long a period. Condemnation by underwriters followed in many cases, but the steam plants were continued in operation because the concerns either could not afford replacements or were unwilling to disturb the funds they needed for working capital. Especially was this true of the depression period.

In the past 18 months many new power plants have been installed with the help of the Modernization Credit Plan of the Federal Housing Administration. In practically every case machine and equipment operating efficiency has been increased and it is expected that the resulting reduction in labor and fuel costs will be sufficient, during the 5-year life of the notes, to cover the expenditure.

Illustrative of this fact is the experience of the Mid-States Gummed Paper Company, Chicago. This firm had maintained its machinery at top efficiency and had replaced obsolete equipment; but production, when business improved, was below expectancy. Engineers called in consultation finally discovered that the trouble lay in the power plant. The boiler was not able to provide sufficient power for machinery, so a new boiler, smokestack and automatic stoker were installed. This plant is more than sufficient to handle all machinery and equipment at highest operating capacity and is doing the job at a saving of around $175 per week because of the cheaper fuel which is being used.

Even greater economy was effected by the Gisholt Machine Company, Madison, Wis., with the two modern boilers which replaced those condemned by the underwriters after having been kept in operation two or three years longer than they should have been. The two new boilers, of greater capacity than those torn out, will save $10,000 a year in the cost of providing power and heat for the machinery and building, for the reduction in operating costs will come in savings in fuel and labor as stokers were installed according to a report from the company.

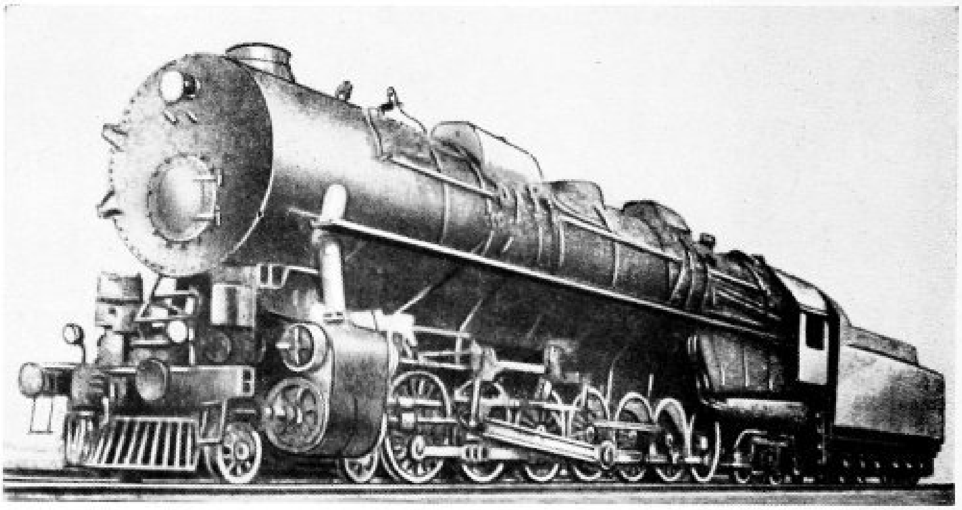
Large factories, manufacturing and industrial plants are not the only places where new and more efficient power plants are needed. In the field of service establishments, particularly cleaning and dyeing plants, any number of boilers have been installed because of the need of more power.

A case in point is the Uptown Cleaners and Dyers, Milwaukee, Wis. An old 10-horsepower boiler proved quite inadequate when this firm installed a cleaning fluid still and other equipment to modernize its plant in order to meet the demands for better and faster service. When the fluid still was being operated, three of the five clothes pressers had to be shut down; and when all pressers were in operation, other equipment had to remain idle. It was impossible to run the plant at full capacity, so a new 40-horsepower boiler was installed, which gave all the steam needed for powering the equipment. It also provided for other uses steam has in a dyeing and cleaning plant, and was much cheaper to operate than the old plant.

Manufacturers of boilers and other power and heating plant equipment have schooled their sales representatives in acquainting possible customers with the advantages of the Modernization Credit Plan. Insurance representatives whose field includes boiler inspection and similar machinery and equipment, often can help owners of condemned plants who are unable to make changes because of unfavorable financial conditions, by showing how they can use government-insured loans.

Under the amended National Housing Act, owners and operators of factories, industrial and manufacturing plants, apartment buildings, hotels, offices, hospitals, colleges, schools and other property may borrow up to $50,000 in modernization credits for property improvements and the purchase and installation of equipment and machinery. While the Federal Housing Administration does not lend money, it insures commercial banks, building and loan associations, trust companies and other private lending agencies extending modernization credit up to 20 percent of the total amount of all loans advanced. The terms of the loan are agreed upon by the borrower and the lending agency which has authority to complete the transaction without referring to the Federal Housing Administration. The interest rate and other charges may be as low as the lending agency agrees to, but in no case can the total charges exceed the equivalent of a $5 discount per $100 original face amount of a one-year monthly instalment note.

"Equipment and Machinery Eligible for Modernization Credit" is the name of a booklet published by the Federal Housing Administration. It contains a résumé of the modernization provisions of the National Housing Act as well as a partial list of the machinery and equipment eligible for government-insured financing. Copies of this booklet may be had by writing the Federal Housing Administration, Washington, D. C.



Articulated 4-14-4 locomotive for Soviet railway

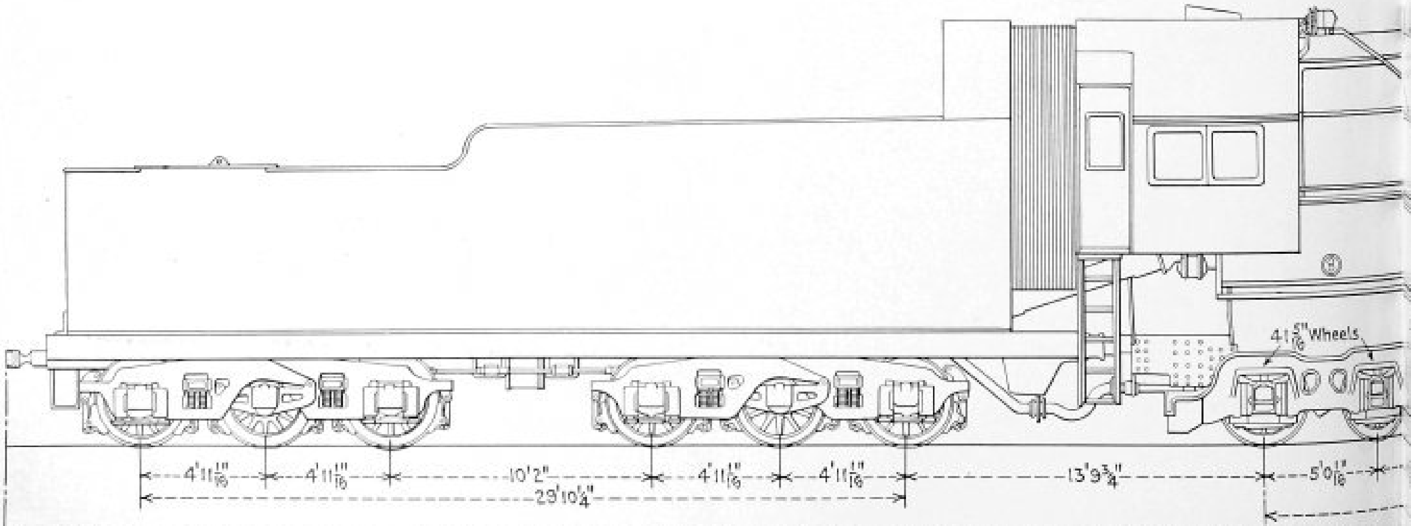
Russia Builds Heavy Power*

By D. Babenko

A study to determine the heaviest type of freight locomotive that could be used on Russian railroads was initiated in 1930. Operating conditions imposed the following restrictions under which the design was to be worked out: (1) Locomotive must operate on existing light track where the rails weigh only 76 pounds per yard. To relay the track with rails weighing 100 pounds or more per yard and to replace the present light bridges was considered prohibitive. (2) Curves in main-line track of 525-foot radius must be negotiated at full speed, and even sharper curves at reduced speeds. (3) Operating speeds up to 43.5 miles per hour. (4) Trains of 2750 short tons to be run at a speed of 15 miles per hour on specified heavy grades. (5) Wear of track on curves and side thrusts to be as low as possible. (6) Stresses on the track, due to dynamic augment at highest running speeds, not to be dangerous despite the light weight of the rails. (7) Fuel to be coal of available low grade and slow-burning quality. (8) Axle load limited to 20 metric tons, or 44,000 pounds. (9) Tractive force at least 60,000 pounds at speed.

It will be readily seen that the above restrictions made the working out of the design a particularly difficult one and raised many problems which had to be solved before construction could be started. Calculations showed that a locomotive which would meet the requirements would have to weigh about 308,000 pounds on the drivers and have a rated starting tractive force of 88,000 pounds. Furthermore, the adhesive weight would have to be distributed on seven axles.

* From a translation of an article which appeared in *The Motive Power*, published in Moscow, U.S.S.R.



Elevation of Russian locomotive

The use of articulated locomotives, such as the Mallet or the Garratt was naturally given consideration, but in view of their rather low efficiency and heavy maintenance costs, the adoption of an articulated design was not considered advisable.

The only alternative to an articulated design was the use of a larger number of coupled axles in a locomotive having a single frame—a greater number than on any locomotive then in operation in Russia. Continuing the investigation, which was started in the spring of 1930, it was found that non-articulated locomotives of the 2-10-0 type were being operated successfully in Germany, also locomotives of the 2-10-2, 2-10-4, 4-10-2 and 4-12-2 types in the United States. These locomotives were of the desired power, but in most cases they had an axle load in excess of 60,000 pounds. Due to the greatly restricted axle loads—44,000 pounds per axle—necessary for operation on 76-pound rails, a locomotive of the desired power would require the employment of seven coupled axles, or a locomotive of the 2-14-2 type. A preliminary design of a two-cylinder, 2-14-4 type locomotive was worked out in the early part of 1931, for which a four-wheel trailing truck was provided, due to the large firebox found necessary.

After the preliminary design had been gone over and had received tentative approval, it was decided that it would be advisable before starting construction to send representatives to other countries to investigate the results obtained from locomotives having five or six coupled axles. Accordingly, three engineers were sent to Germany and later to the United States, where they investigated manufacturing and maintenance facilities and inspected and rode on a number of heavy, non-articulated locomotives.

Upon their return the preliminary designs for a 2-14-4 type locomotive were again gone over in light of the information gathered and a modified design was worked out for a locomotive of the 4-14-4 type. After the design had been checked and approved an order for the construction of a sample locomotive was given to the Lugansk Locomotive Works.

The locomotive has now been completed and has made some trial runs before being placed in service. Handling a train of 1400 short tons, a speed of 25 miles per hour was obtained on a heavy grade, under which conditions the locomotive developed 3000 horsepower. When cold the locomotive was pulled around a curve of 453-foot radius; under steam it passed over a curve of 820-foot radius at a speed of 28 miles per hour.

This locomotive weighs 458,435 pounds in working condition, of which 308,560 pounds is carried on the 14 driving wheels. The four-wheel engine truck carries a load of 68,325 pounds and the four-wheel trailing truck, 81,350 pounds. The driving wheels are 63 inches in diameter, the two cylinders are 29⅛ inches in diameter, and have a stroke of 31⅞ inches, while the boiler pressure carried is 242 pounds per square inch. The rated tractive force on an 85-percent basis is consequently 88,250 pounds. The light weight of the locomotive is 399,600 pounds.

The wheel base of the locomotive is 56 feet 9⅞ inches, and that of the locomotive and tender, 105 feet 5⅞ inches. The driving-wheel base is 32 feet 11⅝ inches. The length of the locomotive between coupler faces is 67 feet 11⅝ inches, and the combined length of the locomotive and tender is 110 feet 8³⁄₁₆ inches.

The tender weighs 275,500 pounds in working order, or 130,040 pounds light, and is mounted on two six-wheel trucks of the Buckeye type, of 9 feet 10⅛ inches wheelbase. It has a capacity for 11,620 U. S. gallons of water and 24.2 tons of coal. The length of the tender between coupler faces is 44 feet 1¼ inches and the wheel base is 31 feet 6⅛ inches.

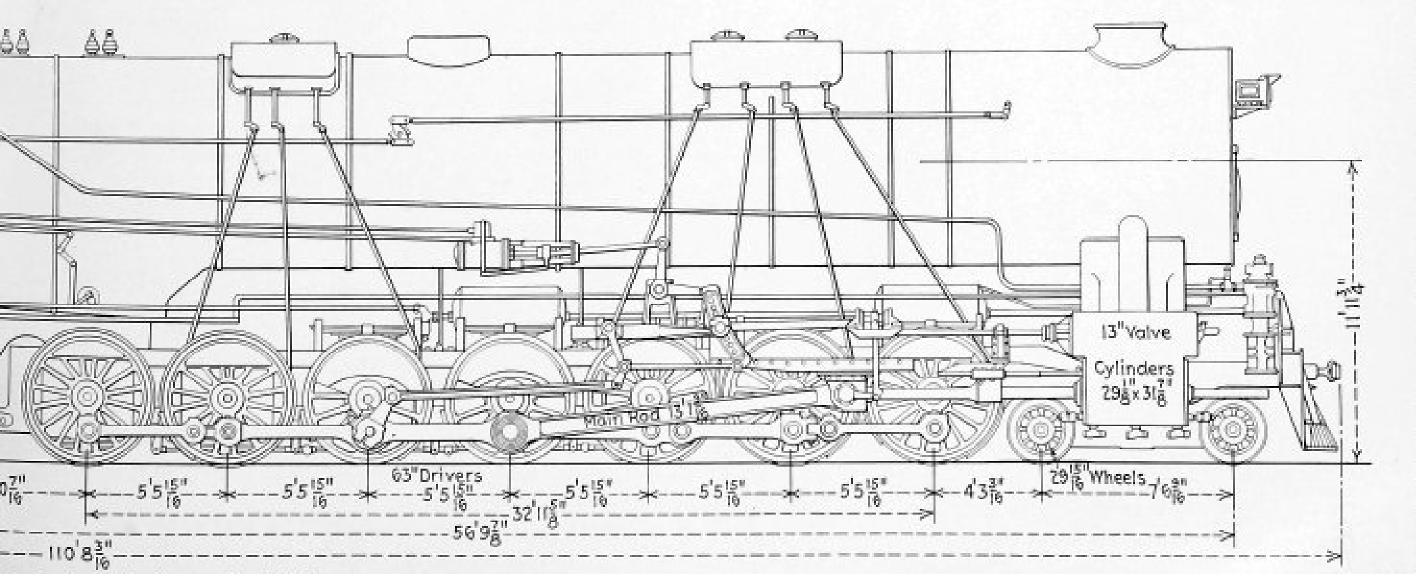
Many of the features of this unusual locomotive are particularly interesting.

Especially noticeable is the large size of the boiler and the firebox. The boiler is of the straight-top radial-stayed type, the center line being 11 feet 11¾ inches above the top of the rail. The total length of the boiler is 58 feet 7⅝ inches and its weight is approximately 132,000 pounds.

The firebox is 15 feet 9 inches long and 8 feet 2⁷⁄₁₆ inches wide, which gives a grate area of 129.2 square feet. Such a large grate area would not be required were the coal not of such a low grade. The grates are of the shaking type and a grate shaker operated by either steam of compressed air is provided. The coal is fed by a mechanical stoker. The ash pan is of the hopper type.

A combustion chamber, 8 feet 2⁷⁄₁₆ inches long, is provided which increases the firebox volume to 865.2 cubic feet. A brick arch is applied, the arch being carried on four arch tubes of 3½ inches diameter.

There are 138 fire tubes, 2¼ inches outside diameter, and 48 flues, 6¼ inches in diameter. Tubes and flues



at the Lugansk Locomotive Works

Table of Dimensions, Weights and Proportions of the Russian 4-14-4 Type Locomotive

Railroad	U. S. S. R (Russian)
Date built	1934
Builder	Lugansk Loco. Works
Type of locomotive	4-14-4
Service	Freight
Track gage	5 ft.
Cylinders, diameter and stroke (2)	29 1/8 in. by 31 7/8 in.
Valve gear, type	Walschaert
Valves (piston type):	
Size	13 in.
Maximum travel	7 13/16 in.
Steam lap	2 in.
Exhaust clearance	0 in.
Lead in full gear	5/16 in.
Weights in working order:	
On drivers	308,560 lb.
On front truck	68,325 lb.
On trailing truck	81,550 lb.
Total engine	458,435 lb.
Tender	275,500 lb.
Wheel bases:	
Driving	32 ft. 11 5/8 in.
Total engine	56 ft. 9 7/8 in.
Total engine and tender	100 ft. 5 7/8 in.
Wheels, diameter outside tires:	
Driving	63 in.
Front truck	29 15/16 in.
Trailing truck	41 5/16 in.
Journals, diameter and length:	
Driving, main (No. 4)	12 5/8 in. by 14 15/16 in.
Driving, tandem (No. 5)	11 in. by 14 15/16 in.
Driving, others	9 7/16 in. by 14 15/16 in.
Front truck	7 1/2 in. by 13 3/4 in.
Trailing truck	7 7/8 in. by 13 1/4 in.
Boiler:	
Type	Radial stayed
Steam pressure	242 lb.
Fuel	Low grade coal
Firebox, length and width (grate)	189 in. by 98 7/16 in.
Arch tubes—number and diameter	4—3 1/2 in.
Combustion chamber length	98 7/16 in.
Tubes—number and diameter	138—2 1/4 in.
Flues—number and diameter	48—6 3/4 in.
Length over tube sheets	22 ft. 11 9/16 in.
Firebox volume	865.2 cu. ft.
Grate type	Shaking
Grate area	129.2 sq. ft.
Heating surfaces:	
Firebox and combustion chamber	543.2 sq. ft.
Arch tubes	52.2 sq. ft.
Firebox, total	595.4 sq. ft.
Tubes	1,942.1 sq. ft.
Flues	2,285.2 sq. ft.
Total evaporative	4,822.7 sq. ft.
Superheating	1,872.9 sq. ft.
Combined evaporative and superheating	6,695.6 sq. ft.
Special equipment:	
Brick arch	Yes
Superheater	Chussov
Exhaust steam injectors	2
Stoker	Yes
Booster	No
Tender:	
Water capacity	11,620 gal.
Fuel capacity	24.2 tons
Trucks	6-wheel
General data (estimated):	
Rated tractive force, 85 percent	88,250 lb.
Boiler horsepower (Cook)	3,880 hp.
Speed at 1000 ft. piston speed	35.3 m.p.h.
Piston speed (ft. per min.) at 10 m.p.h.	283.5
Weight proportions:	
Weight on drivers ÷ total weight engine, percent	67.4
Weight on drivers ÷ tractive force	3.5
Total weight engine ÷ potential horsepower	118.2
Total weight engine ÷ combined heating surface	68.5
Boiler capacity and proportions:	
Evaporative capacity, lb. per hr. (with heater), estimated	73,716
Equivalent evaporative (sq. ft. heating surface per hr.) (with heater), estimated	15.3
Firebox heat. surface, percent com. heat. surface	8.9
Tube-flue heating surface, percent combined heating surface	63.1
Superheating surface, percent comb. heat. surface	28.0
Firebox heating surface ÷ grate area	4.6
Tube-flue heating surface ÷ grate area	32.7
Superheating surface ÷ grate area	14.5
Combined heating surface ÷ grate area	51.8
Potential horsepower ÷ grate area	30.0
Combined heating surface ÷ potential horsepower	1,725
Tractive force ÷ combined heating surface	12.28
Tractive force × diameter drivers ÷ combined heating surface	774

are 22 feet 11 9/16 inches long. This great length accounts for the use of tubes and flues of such large diameter.

The Chussov superheater is of the six-tube type, the outside diameter of the tubes being 1 3/16 inches. The elements extend to within 22 13/16 inches of the back tube sheet.

The evaporative heating surface of the boiler has an area of 4822.7 square feet, of which 594.4 square feet is in the firebox and 4227.3 square feet in the tubes and flues. Adding 1872.9 square feet superheating surface brings the combined evaporating and superheating surface to 6695.6 square feet.

The evaporative capacity of the boiler is estimated to be 73,716 pounds per hour, which corresponds to a potential or boiler horsepower of 3880. Assuming a combustion rate of 82 pounds per square foot of grate per hour, the total amount of coal burned would be 10,594 pounds per hour. If one horsepower could be developed for each 2.65 pounds of coal, the total horsepower would be 4000.

A particularly interesting feature of the boiler construction is the extensive manner in which welding was employed, mainly to keep down the weight, but partly to permit of the use of sheets of readily available sizes. All welded seams are of V shape and are located between lines of staybolts. The firebox sheets, both inside and outside, are welded, being formed of several sheets joined together by welding. The crown sheet and back boiler head are also made of two or more sheets with welded joints.

The boiler is fed by two exhaust steam injectors having a capacity of 95 to 100 U. S. gallons per minute. Two Friedman live steam injectors, having a capacity of 45 to 48 U. S. gallons per minute are also provided. Two blow-off cocks are applied on each side of the firebox.

Machinery's Contribution to Industrial Progress

In a recent study by the Machinery and Allied Products Institute, answers were found to the many present day fallacies concerning machinery and its effect on employment and the general welfare. In the course of the report on this study, ten salient facts were brought forth which are briefly summarized as follows:

(1) Between 1870 and 1930 the population of the United States increased 218 percent and the gainfully employed increased 291 percent. At the beginning of this period, before the great strides in technological advancement had taken place, 32.4 percent of the population was employed, and in 1930 the demands for more goods and services for a higher standard of living furnished employment for 40 percent of the population. There were 20,000,000 more jobs in 1930 than there were in 1900.

(2) Employment today is nearest normal levels in the most highly mechanized industries, such as automobile and textile manufacturing, in the paper and printing trades and other intensely developed industries. Most unemployment is in occupations in which machines are used least.

(3) One of each seven factory workers today has a job making some product that was unknown to his grandfather fifty years ago. It may be conservatively estimated that one out of every four persons gainfully employed today owes his job to one of eighteen new industries which have been developed since 1880.

(4) Between 1920 and 1930 the nineteen principal growing occupations gained almost three times as many workers as the nineteen principal vanishing occupations lost. In almost every case work in the growing occupations was less strenuous, less hazardous and better paying than work in the declining occupations. This improvement has been true throughout the development of machinery. Child labor, for instance, declined from one out of every five children between the ages of ten and fifteen years working in 1900 to less than one out of twenty in 1930.

(5) Only 4 percent of about 2,500,000 unemployed studied in the Federal Unemployment Census of April, 1930, reported that they lost their jobs on account of "industrial policy," under which the displacement of men by machines were listed as one of several sub-classifications.

(6) Eighty-four percent of all machines invented are "labor serving" and only 16 percent have as their primary purpose "labor saving."

(7) Real wages more than doubled between 1900 and 1935 as a result of greater production. In this period production per wage earner increased 68 percent, but to make this increase possible manufacturers installed 331 percent more equipment, measured in horsepower. While production of American factories increased 216 percent between 1899 and 1929, wages paid to labor increased 479 percent.

(8) Industries which advance most rapidly along technological lines draw most heavily on the labor supply, while those mechanized more slowly absorb smaller portions of the available working force.

(9) Had it been necessary to increase hand labor in the same proportion as production between 1900 and 1930, every adult man and woman in the nation and several million children would have been needed in jobs. It would have required more than 60 percent of the entire population to provide the goods and services of a higher standard of living whereas only about 40 percent ever seeks employment.

(10) A 75 percent increase in the 1929 production level would be necessary to provide a "reasonable" standard of living for every family in the United States, according to the Bureau of Home Economics of the U. S. Department of Agriculture. From this it would appear that there is still plenty for both men and machines to do.

Greater New York Safety Conference Meets

The seventh annual meeting of the Greater New York Safety Conference was held at Hotel Astor, March 3, 4 and 5, with a large group of distinguished speakers, who represented a wide range of ideas and viewpoints on industrial, home and municipal safety. The slogan adopted by the conference this year was "It is Intelligent to be Safe." The policy of the safety program for the coming year is not to attempt to frighten the public into being more careful, but rather to appeal to their intelligence in order to combat accidents. The past year has shown a slight decrease from 1934 in the number of fatalities resulting from accidents. The following table, taken from the February issue of *Public Safety*, indicates the gains and losses of the four principal causes of accidental deaths in the United States.

	1935	1934
Totals*	99,000	101,139**
Motor Vehicle	36,400	36,101**
Other Public	17,500	17,500
Home	31,500	34,500
Occupational	16,500	16,000

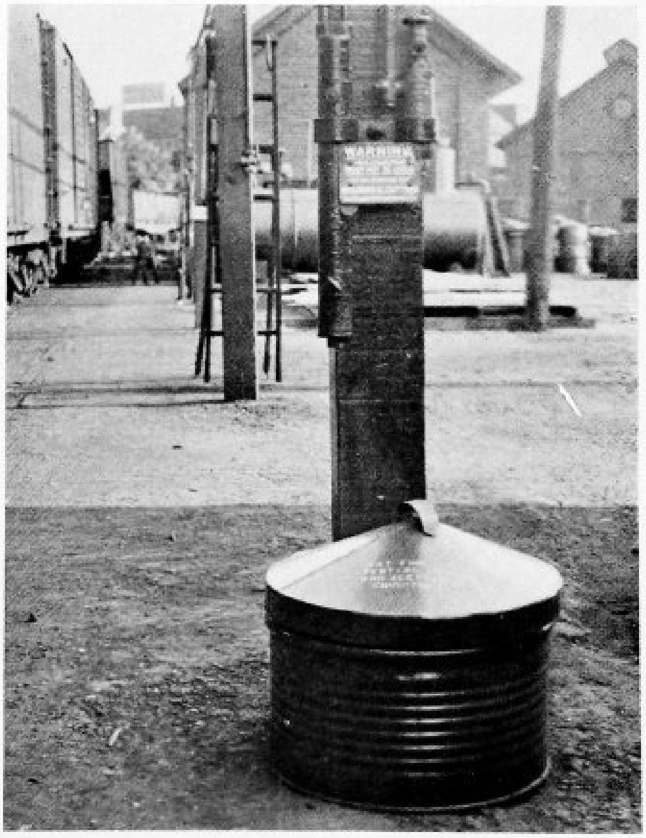
* Totals eliminate duplication of about 3000 occupational motor vehicle deaths each year.
** U. S. Census Bureau figures; all others are National Safety Council estimates.

Vat for Testing Cutting Outfits

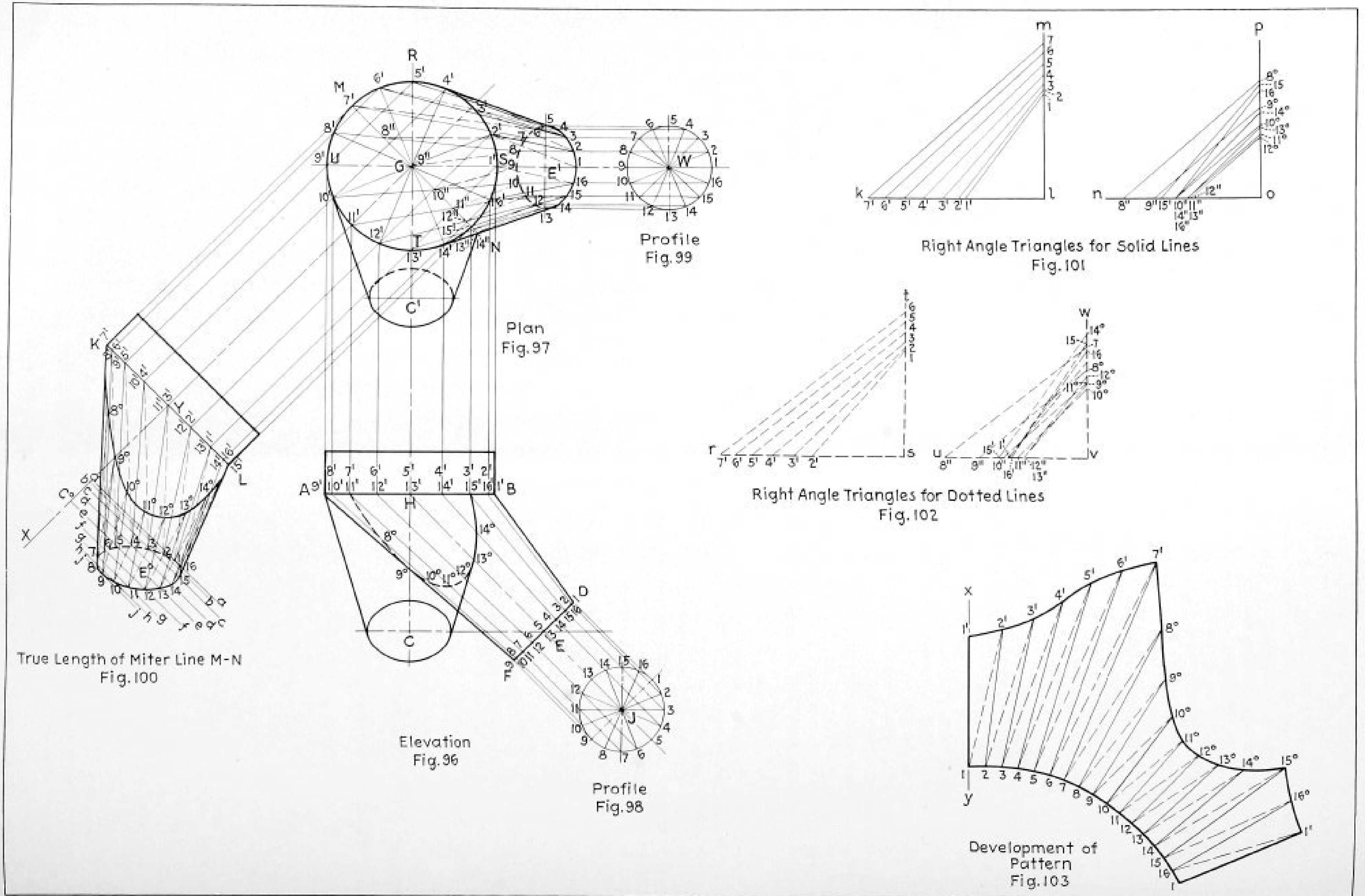
A vat, filled with cold water and located under each oxygen and acetylene connection, has been provided by the car foreman on one railroad for the purpose of having the oxy-acetylene outfits—including the torch and hose connections—tested before the burner or welder starts to work.

Where leaks are detected the connection is tightened and again tested. If it should develop that the torch is defective, a repaired one is drawn from the tool room and the defective one turned in. This precaution will not only eliminate many accidents due to back-fire but will eliminate waste of oxygen and acetylene.

The vat can be of any size and depth desired. However, the one shown in the illustration was made from the bottom portion of an unreturnable oil drum. The lid was made locally by the sheet metal worker and should be provided to keep out dirt when the vat is not being used for testing purposes.



The practice of testing cutting torches and hose before use reduces accidents and saves gas



Details of branch pipe layout and pattern development

PRACTICAL PLATE DEVELOPMENT—XI

Branch Pipe

By George M. Davies

The branch pipe to be considered is illustrated in Figs. 96 and 97 and consists of a main pipe with two tapered branches, the outlets of which are at right angles to each other.

An examination of the plan indicates that the branch pipe can be divided into two halves, by drawing the line *M-N* through the plan, the line *M-N* bisecting the angle *C'-G'-E'*. Thus by dividing the object into two symmetrical halves, it will only be necessary to make a development of one half and duplicate the same for the other half.

The line *M-N* will be the miter line between the two halves and the first step in the development is to obtain the true length of this line.

Obtaining the True Length of the Miter Line

Extend the line *H-E* and at any point as *J* on *H-E* draw the profile of the small end of the tapered branch, as shown in Fig. 98.

Divide the profile Fig. 98 into any number of equal parts, the greater the number of equal parts taken the more accurate will be the contour of the miter line and also the final development. Sixteen parts are taken in this case. Number the divisions from 1 to 16 as shown.

Parallel to the line *H-J* draw lines through the points 1 to 16 cutting the line *F-D* at points 1 to 16 as shown.

Next divide the plan view of the main pipe *R-S-T-U* into the same number of equal parts as was taken in the profile, Fig. 98, and number these points from 1' to 16' in corresponding relation to the points 1 to 16 in Fig. 98, as shown.

Parallel to the center line *R-C* draw lines through the points 1' to 16' of the plan and extend same into the elevation cutting the line *A-B;* number these points from 1' to 16' as shown. Connect the points 1-1', 2-2', 3-3' to 16-16' in the elevation, Fig. 96 as shown.

Next extend the line *U-S* of the plan and at any point as *W* draw the profile, Fig. 99, using the same diameter as was taken in Fig. 98. Divide the profile into the same number of equal parts as were taken in profile, Fig. 98 and number the points from 1 to 16 corresponding to the same points in Fig. 98 as shown.

Then parallel to the line *U-W* draw a line through the points 1 to 16 and extend same into the plan view. Next draw a line parallel to the center line *R-C* through the point 1, Fig. 96, and extend same into the plan cutting the line just drawn through the point 1 of the profile, Fig. 99, locating the point 1 in the plan, Fig. 97. Continue in this manner drawing lines parallel to *R-C* through the points 2 to 16, Fig. 96 and cutting their corresponding lines drawn parallel to *U-W*, obtaining the points 2 to 16 in the plan view, Fig. 97.

Connect the points with a line which will complete plan view of the small end of the branch.

Connect the points 1-1', 2-2', 3-3', to 16-16' in the plan view, Fig. 97, and where the lines connecting 8-8', 9-9', 10-10', 11-11', 12-12', 13-13', 14-14' cut the miter line *M-N* number these points from 8" to 14" as shown.

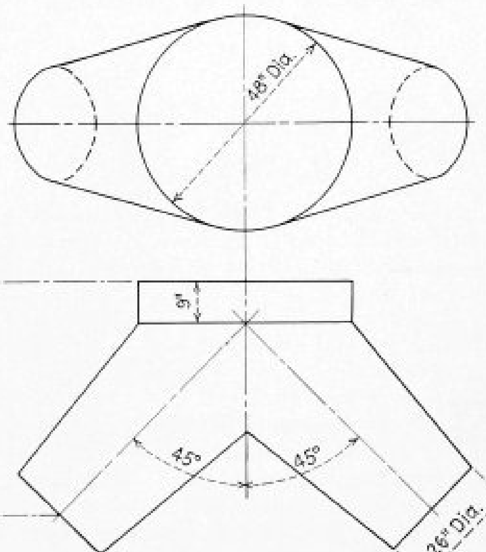
Then parallel to the center line *R-C* draw a line through the point 8" cutting the line 8-8', Fig. 96, locating the point 8°, Fig. 96. In like manner locate the points 9°, 10°, 11°, 12°, 13°, 14°. Connect the points 7', 8°, 9°, 10°, 11°, 12°, 13°, 14°, 15' with a line. This line will be the contour of the miter line *M-N* in the elevation.

Next at *G* erect a perpendicular to the line *M-N* as *G-X* and at any point on *G-X* as *Y* draw a perpendicular to *G-X* as *K-L* Fig. 100.

Then draw lines parallel to the center line *G-X* through the points 1' to 16', Fig. 97 cutting the line *K-L*, Fig. 100. Number these points corresponding to the same points in the plan view, Fig. 97 from 1' to 16' as shown.

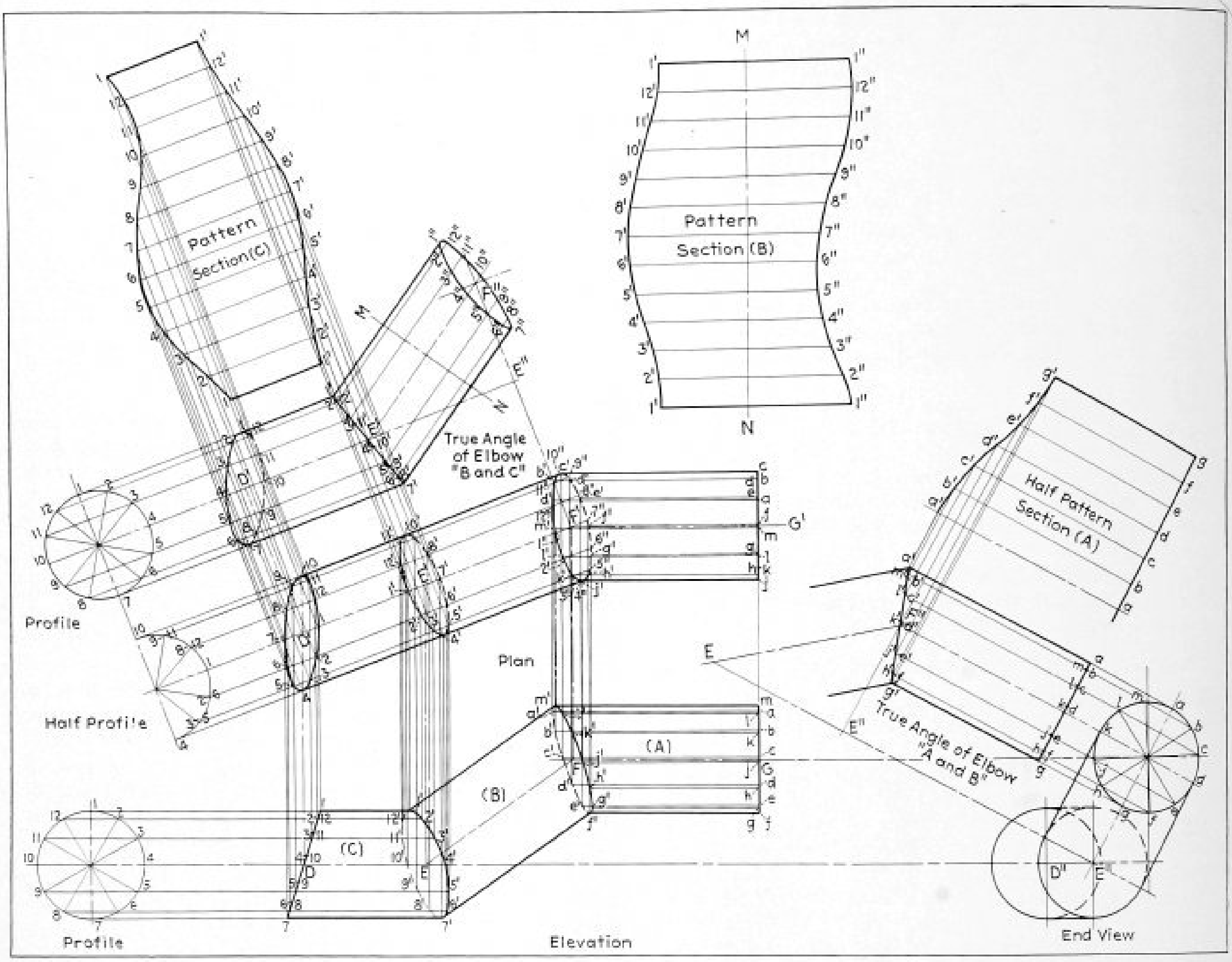
On *G-X* at *Y* step off the distance *Y-C°* equal in

PROBLEM No.9



Practice problem No. 9 for readers to lay out will be solved in the May issue

Problem No. 8 – Correct Layout



Problem No. 8, was published in connection with instructions for laying out a smokestack connection piece which appeared on page 347 of the December, 1935, issue

length to *H-C*, Fig. 96, and at *C*° erect a perpendicular to *X-Y*. Then parallel to *G-X* draw line through the point *E'*, Fig. 97, cutting the perpendicular just drawn locating the point *E*°, Fig. 100.

Then parallel to *C*°-*E*° draw the line *a-a*, the vertical distance between the line *C*°-*E*° and *a-a* being the same as the vertical distance between the line *C-E* and the line point 1 in Fig. 96.

In like manner draw the lines *b-b*, *c-c*, *d-d* to *j-j*, the spacing above and below the line *C*°-*E*° being taken equal to the vertical distances between the line *C-E* and the point 2 to 9 in Fig. 96.

Then parallel to the line *G-X* draw a line through the point 1 Fig. 97, and extend same into Fig. 100 cutting the line *a-a*, locating the point 1, Fig. 100. In like manner draw a line through the points 2 and where this line cuts *b-b* will locate the point 2, Fig. 100. Continue in this manner until the points 3 to 16, Fig. 100, are located. Connect the points 1 to 16 with a line which represents the contour of the same end of the branch pipe in Fig. 100. Connect points 1-1', 2-2', 3-3', to 16-16', Fig. 100.

Then parallel to the line *G-X*, draw a line through the point 8", Fig. 97, and extend same into Fig. 100, cutting the line 8-8' locating the point 8°, Fig. 100. In like manner locate the points 9°, 10°, 11°, 12°, 13°, 14°. Connect the points 7', 8°, 9°, 10°, 11°, 12°, 13°, 14°, 15' with a line which will be the true length of the miter line *M-N*.

Next connect the points 1-1', 2-2', 3-3', 4-4', 5-5', 6-6', 7-7', 8-8", 9-9", 10-10", 11-11", 12-12", 13-13", 14-14", 15-15', 16-16', Fig. 97 with solid lines and the points 1-2', 2-3', 3-4', 4-5', 5-6', 6-7', 7-8", 8-9", 9-10", 10-11", 11-12", 12-13", 13-14", 14-15', 15-16' with dotted lines, these lines represent the surface lines of the object in the plan view.

Then connect the points 1-1', 2-2', 3-3', 4-4', 5-5', 6-6', 7-7', 8-8°, 9-9°, 10-10°, 11-11°, 12-12°, 13-13°, 14-14°, 15-15', 16-16', Fig. 100, with solid lines and the points 1-2', 2-3', 3-4', 4-5', 5-6', 6-7', 7-8°, 8-9°, 9-10° 10-11°, 11-12°, 12-13°, 13-14°, 14-15', 15-16' with dotted lines; these lines represent the surface lines of the object in Fig. 100.

In order to make a development it is first necessary to obtain the true lengths of all the surface lines of the object and this is done by making a series of right angle triangles as shown in Figs. 101 and 102.

Draw any line k-l and at l erect a perpendicular to k-l as l-m. On k-l from l step off the distance l-1, l-2 to l-7 equal to 1-1′, 2-2′, to 7-7′, Fig. 97; then on the perpendicular l-m from l step off the distances l-1′, l-2′, l-3′ to l-7′ equal to vertical distance between the points 1-1′, 2-2′, 3-3′ to 7-7′, Fig. 100. The vertical distance should be measured parallel to X-Y.

Connect the points 1-1′, 2-2′, 3-3′ to 7-7′ with solid lines which will be the true length of the solid line 1-1′, 2-2′ to 7-7′.

Continue in this manner obtaining the true lengths of all the solid and dotted lines, the bases of the right angle triangles in all cases being taken from the plan, Fig. 97, and the altitudes being taken in all cases from Fig. 100.

Development of the Pattern

Draw any line as x-y, Fig. 103, and step off on x-y the distance 1-1′ taken equal to the distance 1-1′, Fig. 101. Then with 1′ as a center and with the dividers set equal to the distance 1′-2′, Fig. 97, scribe an arc. With 1 as a center and with the trams set equal to 1-2′, Fig. 102, scribe an arc cutting the arc just drawn locating the point 2′, Fig. 103.

Then with 1, Fig. 103, as a center and with the dividers set equal to 1-2 of the profile, Fig. 98, scribe an arc. With 2′, Fig. 103, as a center and with the trams set equal to 2-2′, Fig. 101, scribe an arc cutting the arc just drawn locating the point 2, Fig. 103.

Continue in this manner, taking the short arc distances 2-3, 3-4, to 15-16 from the profile, Fig. 98, and the long arc distances 2′-3, to 6′-7′ and 15′-16′, 16′-7′ from the plan view, Fig. 97, and 7′-8°, 8°-9° to 14°-15′ from the true length of the miter line, Fig. 100.

The length of the solid and dotted lines are taken from their corresponding distances in Figs. 102 and 103.

Connect all points with a solid line, completing the outline of the pattern of one-half of the branch pipe, a duplicate of this pattern being necessary to complete the pipe.

(To be continued)

What About Mechanics and Supervisors for the Future?

*By E. C. Williams**

The average railroad man of today is 40 years of age, or older, and in a few more years will pass on over the hill and out of the picture. Our railroads are giving little thought to the training of the younger generation to take care of this critical situation; only a few young men are serving any kind of apprenticeship in our railroad shops today. In ten short years the average mechanic of today will be retired from service or will have passed away.

Who will step in and carry on? We can't say that the mechanics who have been laid off during the days of depression will be the ones, because Old Father Time will also have them, since they will be past the age limit.

Many will say that the apprentices will step in and carry on, but this is also untrue, since apprentices in railroad shops today are almost as scarce as the buffaloes on the plains.

This matter is far more serious than most of us realize. I sincerely hope that some of the leaders will see how vital it is to the future of our railroads, and will make efforts to correct it now, while there is yet time.

In a few years more the equipment that is now in service will be obsolete and will be replaced with modern designs, and then the railroad officials will realize that we, the mechanics of today, are also obsolete and very much out-of-date and will, of course, be of little use, since we were trained to make repairs to the obsolete equipment and our age will not permit us to learn the trade all over again.

I would like to say for the benefit of the young men who are serving their apprenticeship in various shops throughout the country, that I don't believe anyone has a brighter future before them. If they will only apply themselves and do everything in their power to learn about the modern equipment, these young men will be the leaders of the railroads of tomorrow.

An apprentice working part-time, as has been the custom in the past, will put in approximately six calendar years before his apprenticeship is completed, and he is qualified as a journeyman. Then there is another lapse of three to five years of work and experience that he must go through before he can really render the service he should to the company that employs him.

The point that I am trying to stress is this—if all railroads were filled to capacity with apprentices now, it would be a matter of from eight to ten years before the majority of them would have acquired the knowledge and ability to carry on. Many, many of the older men will be gone on by that time, so the railroads have a very serious situation confronting them. Let us hope it will be corrected before it is too late!

* Boiler Foreman, Kansas City Southern, Shreveport, La.

Pacific Coast Steel Fabricators Protest Prices

The Pacific Coast Fabricators, at their annual meeting at Del Monte, Cal., voted to file a formal complaint with the Federal Trade Commission on the allegedly artificially high mill base prices of rolling mills products produced on the west coast. The association declared itself in opposition to the price differential between eastern and Pacific coast mill prices, the granting by the mills of excess equalizing allowances to eastern fabricators doing business in this territory and further went on record as favoring a $4 per ton differential to recognized fabricators on the Pacific coast.

The officers for 1936 elected at this meeting are as follows:

President—Reese H. Taylor, Consolidated Steel Corporation, Los Angeles.

Vice-presidents—Paul Pigott, Pacific Car & Foundry Company, Seattle; George Raitt, Steel Tank & Pipe Company, Berkeley; Charles McGonigle, Poole & McGonigle, Portland.

Secretary-Treasurer—P. F. Gillespie, Judson-Pacific Company, San Francisco.

Assistant Secretary and Manager—T. A. L. Loretz.

Steel Exports

The January figures for steel exports were 241,348 gross tons as compared with 239,268 gross tons in December, according to the Department of Commerce statistics. These results were larger than any previous month since September, 1935.

A breakdown of the figures shows that scrap accounted for 65.8 percent of the whole, with 158,962 gross tons exported as compared with 142,135 gross tons for the previous month. The remaining 82,416 tons were made up of semi-finished, finished steels and ferro alloys.

National Board issues welding rules for

Boiler and Pressure Vessel Repairs

The National Board of Boiler and Pressure Vessel Inspectors in co-operation with the Engineers' Conference of the Boilers and Machinery Department of the National Bureau of Casualty and Surety Underwriters, has issued a revised set of rules governing fusion welding repairs on boilers and unfired pressure vessels. These rules represent a re-issue of similar regulations put out three years ago and have the approval of the Boiler Code Committee of the A.S.M.E.

The rules are as follows:

1. By "fusion welding" is meant a process of welding metals in a molten, or molten and vaporous, state without the application of mechanical pressure or blows. Such welding may be accomplished by the oxy-acetylene or oxy-hydrogen flame or by the electric arc. Thermit welding is also classed as fusion welding.

2. A major repair by fusion welding, such as the repair or making of a new seam, the insertion of nozzles, or any repair involving the safety of a boiler or pressure vessel should be made in accordance with the section of A.S.M.E. Code governing the particular kind of vessel or kind of work to be done. The individual welders employed on such work must have passed satisfactory qualification tests as required by the A.S.M.E. Boiler or Unfired Pressure Vessel Code, and particular attention must be given the requirement that the position (flat, vertical or overhead) in which the welding is done on the test piece shall be the same as will be encountered in making the repair.

Note: The 1934 revision of the Unfired Pressure Vessel Code changes the designation and stamping of fusion welded vessels as follows:

"Class 1 vessels" to "vessel built in accordance with paragraph U-68"

"Class 2 vessels" to "vessel built in accordance with paragraph U-69"

"Class 3 vessels" to "vessel built in accordance with paragraph U-70"

3. No welding repairs shall be made before an inspection has been made by an authorized inspector and the method of repair sanctioned by him. If, in the opinion of the inspector, a hydrostatic test is necessary such test shall be applied when the work is completed.

4. Fusion welding on boilers or pressure vessels by unqualified welding operators will not be acceptable except in the cases specified herein where the safety of the boiler or pressure vessel does not depend upon the weld.

(a) Fusion welds not exceeding three feet in length will be permitted in a staybolted surface or one adequately stayed by other means so that, should the weld fail, the parts would be held together by the stays.

(b) Cracks in girth seams extending from the edge of the plate to the rivet hole may be fusion welded. All cracks that may be welded shall be properly prepared to permit fusion through the entire thickness of the plate. Similar cracks in a longitudinal direction and located between the rivet holes may also be fusion welded, provided the cracks do not extend more than 3 inches beyond the edge of the lap of the inner plate. Cracks extending from rivet hole to rivet hole on girth seams shall not be welded.

(c) Calking edges of girth seams may be built up by fusion welding under the following conditions: The thickness of the original metal between rivet holes and calking edge to be built up shall be not less than ¼ of the diameter of the rivet hole and the portion of the calking edge to be replaced shall not exceed 30 inches in length in a girthwise direction.

(d) Prior to making any repairs to girth seams by fusion welding the rivets shall be removed over the portions to be welded and for a distance of at least 6 inches beyond each such portion. After repairs are made the rivet holes shall be reamed before the rivets are redriven.

(e) When external corrosion has reduced the thickness of plate around handholes to an extent of not more than 40 percent of the original thickness and for a distance not exceeding 2 inches from the edge of the hole, the plate may be built up by fusion welding.

(f) Stayed sheets which have corroded to a depth of not more than 40 percent of their original thickness may be reinforced or built up by fusion welding. In such cases the stays and staybolts shall come completely through the reinforcing metal and the original ends of the staybolts shall be plainly visible to the inspector. When necessary to replace stays and staybolts, they shall comply with the requirements of the A.S.M.E. Code.

(g) In fire tube boilers where tubes enter flat surfaces and the tube sheets have been corroded or where cracks exist in the ligaments, fusion welding may be used to reinforce or repair such defects. The ends of such tubes may be fusion welded to the tube sheets after they have been rolled and beaded. Such repairs for tube sheets and the welding in of tubes in the sheets shall not be permitted where such sheets form the shell or drum of a watertube boiler.

(h) Unreinforced openings in the shells or drums of boilers or pressure vessels, provided they do not exceed in diameter the sizes of unreinforced openings permitted by the A.S.M.E. Code (Par. P-268a or U-59a Revised) may be closed by the use of a patch or plate, at least 2 inches larger in diameter than the hole, placed on the inside of the drum or shell and sealed against leakage by fusion welding, preferably on both the inside and outside edges. Such patches shall not be set in the shell flush with the surrounding plate.

(i) Tubes of fire tube boilers may be re-ended or pieced by the fusion welding process provided such tubes are well distributed and their number does not exceed 50 percent of the total and further that there are no more than two circumferential welds in any one tube. Provided, however that in fire tube boilers tubes that have been re-ended by the fusion welding process may be used in excess of 50 percent of the full number of tubes provided such re-ended tubes have been welded by operators who have demonstrated their ability to obtain sound and ductile welds. Satisfactory evidence of a welding operator's ability in this connection shall be obtained by having the welding operator make several sample welds between two pieces of boiler tubing, the welding to be done under the same conditions and by the same process as will be the case in the actual safe-ending of tubes. After such samples have been welded they shall be cut into longitudinal strips about 1 inch wide, the reinforcement of the weld on the outside, if any, ground off and the specimens then broken at the weld. This method of examination may be accomplished by gripping the specimen at the weld, in a vise, and the extended section driven backward with a hammer so that the weld will be opened at the root. To be satisfactory, welds broken in this manner shall be clean and properly fused through at least 90 percent of the thickness of the tube.

If more than 50 percent re-ended tubes are found in a boiler and it is impossible to have the welding operator who did the work make some sample welds for test, three tubes at various locations shall be removed from the boiler and the welds shall be subjected to the above test.

5. The repairing of tubes or headers in watertube boilers by fusion welding is not permitted.

6. Cracks in the shells or drums of power boilers, except as otherwise specified herein, shall not be welded.

7. The building up of grooved or corroded areas of unstayed internal surfaces, other than widely scattered pitholes, by means of deposited metal is not approved.

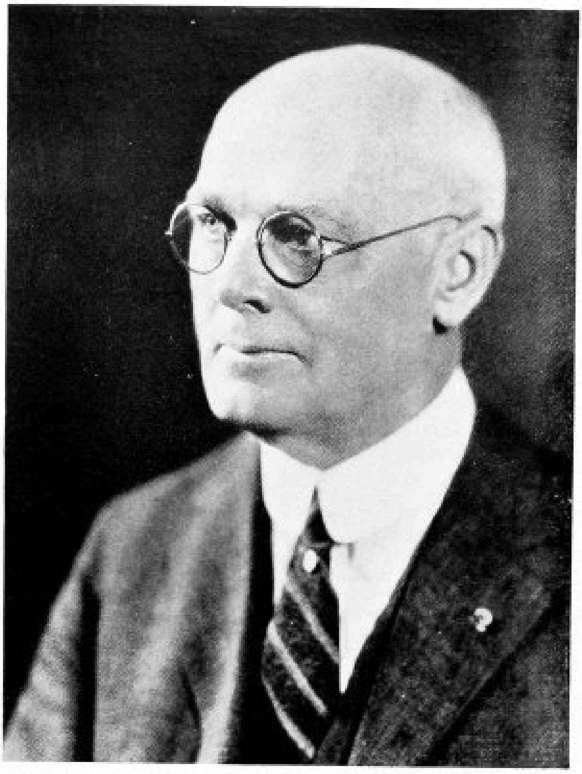
8. Leakage at riveted joints or connections must be carefully investigated to determine the cause of such leakage.

Power Show and Conference

The educational phase of the power industry will be heavily emphasized at the Midwest Engineering and Power Exhibition and the Power Engineering Conference, to be held April 20-24 in Chicago, at the International Amphitheatre and the Palmer House.

To show by contrast what has been accomplished in the last 200 years, several universities have promised to display old models of engines and power equipment, which will be especially fitting on the 200th anniversary of the birth of James Watt. Coal companies will have exhibits of model coal mines, particularly showing the hoisting and sorting of coal. Similarly, Diesel and internal combustion manufacturers will concentrate on understandable exhibits of their products. Electricity will also be emphasized, as will gas and steam power. All major activities of the conference program are virtually complete. There will be 12 sessions with approximately 35 papers by leading engineers, each a recognized authority in his field.

The first day's session will deal with the subject of Power Economics, with C. F. Hirshfeld, of the Detroit Edison Company, and other nationally known engineers as speakers. Power Plant Buildings and Dams, Engines and Electricity will provide the second day's topics and among the speakers are P. E. Stevens of Byllesby Engineering and Management Corporation and Major T. B. Larkin, United States army engineer. The third day's session will concern itself with Refrigeration, Power Piping and Welding, and Fuels, with W. E. Zieber of the York Machinery Corporation, J. R. Dawson of Union Carbon and Carbide, C. C. Wilcox, John Hahn and Joseph Harrington, combustion experts, on the program. The annual banquet will also be held on this day at the Palmer House. The final conference day will feature Power Plant Technics, Power Transmission, and Fuel Economy and Controls and the principal speakers will be N. Rosencrants, New York City, Dr. Hall of Pittsburgh, and J. C. Kuhns of the Staley Company.



Fred R. Low

Fred R. Low, Editor Emeritus of Power

Fred R. Low, past president of the American Society of Mechanical Engineers, an international figure in journalism and engineering, died Wednesday, January 22, at his home in Passaic, N. J., at the age of 75. Mr. Low, at the time of his death, was editor emeritus of the engineering journal *Power*, following 42 years (1888-1930) as its chief editor. He was a former mayor of Passaic, N. J., honorary member of the British Institution of Mechanical Engineers, and honorary Doctor of Engineering, Rensselaer Polytechnic Institute. He was also chairman of two major committees of the American Society of Mechanical Engineers, dealing, respectively, with the codification of safety rules for the construction of steam boilers and unfired pressure vessels and the rules for testing boilers, turbines, engines and other power equipment. In addition, Mr. Low was a member of a large number of technical societies and clubs.

He was born in 1860 in Chelsea, Mass. and at the age of 14 left grammar school to become a clerk in a Western Union office, where he learned telegraphy and stenography. In 1880, he became associated with the Journal of Commerce (Boston) as secretary to the editor and it was through this publication that Mr. Low became interested in engineering. He studied this science in his spare time and became an intimate of many practical engineers, working with them on their technical problems. In 1886, he became editor of the engineering department of the Journal of Commerce and two years later left to become the fifth editor of *Power*.

During the 42 years that Mr. Low was connected with this publication, the field of the magazine was broadened, without changing its practical approach, to serve also the needs of the growing number of professionally trained engineers, designers and consultants in the power field. Mr. Low's active connection with *Power* came to an end in 1930, when he retired due to failing health. Since then, he has maintained his contact insofar as possible with the field in which he was so long prominent, but in later years, illness had confined him rather closely to his home.

Ruling on Water Wall Headers

It has been called to the attention of the executive committee of the National Board of Boiler and Pressure Vessel Inspectors at their meeting in New York City, January 16, last, that certain boiler manufacturers are equipping boilers with water wall headers, superheater headers and water cooling boxes and stokers which are not constructed in accordance with the A.S.M.E. Code and inspected during construction by a qualified inspector. After a thorough discussion of this subject, the following action was taken:

"That water wall headers, superheater headers, all other tubes or headers, and all other parts of boilers that are directly connected to the boiler proper without any intervening shut-off valves, shall be considered as part of the boiler, material and construction of which shall conform with A.S.M.E. Code requirements."

A. S. M. E. Semi-Annual Meeting

The semi-annual meeting of the American Society of Mechanical Engineers at Dallas, Tex., the week of June 15, 1936, has been arranged in conjunction with the Texas Centennial celebration. The A.S.M.E. program will provide for council and committee meetings on June 15 and 16, with technical sessions beginning June 17 and continuing through Friday, June 19. Saturday, June 20, has been set aside by the exhibition authorities as "A.S.M.E. Day" and tentative plans provide a public program with addresses by engineers of national prominence and the broadcasting of their remarks.

The technical program will include papers presented under the auspices of the Aeronautic, Process Industries, Machine Shop Practice, Textile, Railroad, Management, and Petroleum Divisions, as well as a number of papers developed by the North Texas Section on engineering enterprises of the Southwest.

Entertainment will be provided, which should prove attractive to visitors, especially to those coming from the North. Visits to the oil wells of eastern Texas, as well as to a number of plants in the neighborhood of Dallas and Fort Worth, are being arranged. Tentative plans are being considered for visits to old Mexico and southwest Texas.

Bethlehem Merger Plan Ratified

Inter-corporate merger of the Bethlehem Steel Corporation was approved by the stockholders February 25. The Kalman Steel Corporation of Delaware, the Bethlehem Mines Corporation and the Union Iron Works of New Jersey and the Bethlehem Steel Corporation of Delaware will, as a result of this meeting, be merged under the name of the Bethlehem Steel Corporation of Delaware. This action will be effective as soon as legal formalities are completed.

New Officers of Burden Iron Company

At a meeting of the Board of Trustees of the Burden Iron Company, Troy, N. Y., held recently at the company's offices at 250 Park Avenue, New York, Alfred Musso, New York, Robert Kemp, Troy, and O. A. Van Denburgh, Troy, were installed as president, vice-president and secretary, respectively. The following trustees were also elected; Arthur E. Swan, former chief engineer of the Crucible Steel Company of America, Harrison, N. J., and James D. Fleming, Commissioner of Industrial Affairs, Troy. The business of the Burden Iron Company was founded in 1812 and it is the intention of the organization to extend its field of operation by manufacture of new lines of products.

USL Arc Welders Now Being Made by Owen-Dyneto Company

Arc-welding equipment and accessories manufactured by the USL Battery Corporation, Niagara Falls, N. Y., are now being made and sold by the Owen-Dyneto Corporation, Syracuse, N. Y. Since both these companies are subsidiaries of Electric Auto-Lite, the entire engineering staff, machinery and other equipment of the USL Niagara Falls plant have been transferred to the Syracuse works, and Mr. J. L. Fosnight continues as sales manager of the electric arc-welding division. It is said that in addition to the present USL line, arc welding sets which incorporate new features making for more stable arc, greater welding speed, wider range and more efficient performance, are in process of development.

Republic Purchases Wickwire Spencer Stock Interest

The Republic Steel Corporation, Cleveland, will own in a short time a nine to ten percent stock interest in the Wickwire Spencer Steel Corporation, New York, if recent reorganization plans are approved. It was discovered at a hearing in Buffalo before a Federal court that a loan brokerage firm had purchased $3,040,000 of class B Wickwire Spencer notes in the interest of Republic. These notes would be exchanged for proposed new stock. The necessary two-thirds vote for the reorganizing plan has been obtained from the stockholders, but minority groups may carry their opposition to the courts.

It is expected that Wickwire Spencer's name will be changed to Spencer Wire Products. Plants of this concern are located at Tonawanda, N. Y. and Worcester, Palmer and Clinton, Mass.

Seamless Chromium-Nickel Alloy Steel Tubes in Production

The Babcock & Wilcox Tube Company, Beaver Falls, Pa., has started commercial production of seamless tubes and pipes of an alloyed steel containing 25 percent chromium and 20 percent nickel, suitable for high temperature equipment and in refinery operations. These tubes may be obtained hot-finished in sizes up to 6 inches outside diameter and cold-drawn in smaller sizes.

This alloy has a high degree of oxidation resistance and can be used in continuous operations at temperatures around 2100 degrees F. Its physical properties are ductility and great creep strength. It is expected that these tubes will be used in oil refinery equipment for high temperature cracking and polymerization and in recuperators, thermocouple protection tubes, valves and heat resistant tubular members.

New Directors for Simmons-Boardman

Frederick H. Thompson, vice-president and director of the Simmons-Boardman Publishing Company, publisher of BOILER MAKER AND PLATE FABRICATOR, has been elected also to the board of directors of the parent company, the Simmons-Boardman Publishing Corporation. Frederick C. Koch, also a vice-president of the former company, has been elected to its directorate. The elections took place on February 10 at the respective annual meetings of the two corporations which were held in New York.

Frederick H. Thompson

Mr. Thompson, who was born in Cleveland, started his business career in 1902 as a newspaper reporter in New York. From 1904 to 1907 he was eastern representative of the *Music Trade Review*, becoming in the latter year business manager of the *American Engineer and Railroad Journal*, a position which he held until 1912, when that publication was merged into the *Railway Mechanical Engineer*, a Simmons-Boardman publication. Shortly after the merger Mr. Thompson joined the Simmons - Boardman organization as business manager of the *Railway Mechanical Engineer*, serving in that capacity until 1920, when he was appointed general manager for the Simmons-Boardman Company. In 1924 Mr. Thompson was elected a vice-president and a director in 1931.

Frederick C. Koch

Mr. Koch was born in Jersey City, N. J., on June 9, 1893, and was educated in the public schools of New York. He entered the employ of the *Railway Age-Gazette* in 1909 in a minor capacity and rose through various clerical positions to the position of business manager of *Railway Engineering and Maintenance*, which position he still holds. He was elected vice-president in 1931.

Arc Welders in Southern California

The Hobart Brothers Company, Troy, O., announces that the J. C. Gowing Welding Equipment and Supply Company, Jim Gowing manager, has been appointed exclusive distributor for Hobart electric arc welders in Southern California. Mr. Gowing is well known to the welding industry in California, having been of material help in most of the major welding problems in the Los Angeles area during the last eight years.

New Process for Making Stainless Steel

The Globe Steel Tubes Company, Milwaukee, has developed a new process claimed to render ordinary carbon steel immune to corrosion. The new process, called Ihrigizing, after Dr. H. K. Ihrig, chemical engineer of the company, consists of impregnating the steel with silicon, usually to a depth of 0.02 to 0.03 inch. This treatment is said not to affect the core of the metal, which can still be heat treated. A high polish is given to the surface which becomes highly resistant to the more severe corrosive agents.

Trade Publications

TONCAN IRON.—The January number of *Toncan Topics*, a publication of the Republic Steel Corporation, Cleveland, describes the latest applications of Toncan iron in the form of piping, sheets, wire, gas containers, etc.

Z PILES.—The Carnegie-Illinois Steel Corporation, Pittsburgh, has prepared an addition to the Carnegie Steel Sheet Piling Book on the subject of Z Piles. It covers the subject in the same thorough manner as previous Carnegie publications.

ANTI-EROSION PAINT.—The Debevoise Company, paint makers, have recently issued a publication dealing with Debecote, a preparation used on condenser tubes and other metals, where severe erosion takes place due to violent water turbulence.

MULTIPLE RETORT STOKER.—An attractive 8-page bulletin just issued by Combustion Engineering Company, Inc., New York, describes and illustrates in detail its "Design MRO" multiple-retort stoker. Test data and typical operating results are included.

COMPRESSORS.—A bulletin describing power-driven, horizontal duplex, double-acting, heavy-duty compressors produced by the Ingersoll-Rand Company, Phillipsburg, N. J., has just been issued. The capacities of the compressors described range from 50 to 250 horse power for single or multi-stage compression.

BRONZE WELDING.—The Linde Air Products Company, New York, has recently issued a bulletin incorporating the available information on bronze welding and bronze surfacing. It is a presentation of the theory and technique connected with this trade and brings out the advantages of the use of bronze in welding.

NICKEL STEEL.—The International Nickel Company, New York, has recently issued the latest number of Nickel Steel Topics. This bulletin contains articles on new high-speed trains, other railway equipment, automotive parts, airplane construction and heavy forgings and casings, all of which make some use of nickel steel.

WROUGHT IRON.—The use of wrought iron in industry as applied to piping, smokestacks, coal hoppers, condenser tubes, tanks, boiler tubes and breeching, marine hull plating and framing is fully illustrated and described in two catalogues recently brought out by the A. M. Byers Company, Pittsburgh, manufacturers of wrought iron.

BOX HEADER BOILER.—An illustrated catalogue has just been published by the Combustion Engineering Corporation, New York, on the CE-Heine box header boiler. A brief history of this boiler since its inception in 1882 is given, along with numerous descriptive matter on details, layouts and installation arrangements of the Heine boiler.

OPTICAL PYROMETER.—The Pyrometer Instrument Company, New York, has on hand a new catalogue describing the new Pyro Optical pyrometer, an instrument embodying many advanced and unique features. It is a self-contained, direct reading precision instrument with no correction charts or curves to consult, so that speed and ease of operation are its chief characteristics.

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

VOLUME XXXVI NUMBER 3

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Request for change of address should reach us on or before the 15th of the month preceding the issue with which it is to go into effect. It is difficult and often impossible, to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address, please be sure to send us your old address as well as the new one.

BOILER MAKER AND PLATE FABRICATOR is a member of the Associated Business Papers, Inc. (A. B. P.), and the Audit Bureau of Circulation, (A. B. C.)

EDITORIAL STAFF: H. H. Brown, Editor. L. S. Blodgett, Managing Editor H. W. MacDonald, Associate Editor.
BUSINESS MANAGER: Warner Lumbard.

Contents

ELECTRIC WELDING PRODUCTS.—The Air Reduction Sales Company, New York, has just issued a 32-page catalogue in which electric welding products, electrodes, arc welding machines and miscellaneous apparatus used in welding are described and illustrated. A section of the catalogue is devoted to a group of tables useful to a welder; such as, arc welding table, arc voltage chart, amperage chart and approximate weights of welding rods.

BOILER TUBE CLEANERS.—A manual has just been published by the Roto Company, Newark, N. J., manufacturers of tube cleaners, on the subject of boiler tube cleaning and devices for such cleaning. The publication illustrates and discusses with photographs and blue prints various problems of mechanical tube cleaning and their solution. It also analyzes all the various makes and types of tube cleaners now available and suggests the type of cleaner to be used for specific purposes. A section is also devoted to boiler scale, its formation and prevention, and the losses due to scale and frequency of tube cleaning.

The Boiler Maker's Lament

A reader breaks into verse, voicing the woes of the boiler maker in the following:

An apprentice boy starts out from school,
Must not be weak and not a fool;
Heats rivets first to learn the trade,
And holds them on in sun or shade.

Hard raps he takes and pain endures,
Mashed fingers, toes, till practice cures,
Small wages gets for all his pains—
"His future" all his promised gains.

Long years of steady work by him
But subject to the foreman's whim,
At last his goal he reaches now
"I'll start a home, and save I vow!"

He works with pride of goal achieved
And sings for joy, does not get peeved,
When he must step in soot knee deep,
For he must make his spirit keep.

He rolls in filth and grime and dirt,
He beats and pounds till muscles hurt,
In boilers hot from the fiery blast
He tries to stick it out and last.

The muck rolls down his neck and shoes
But he can't "afford" to get "the blues."
His clothes are soaking through from sweat;
He comes out of boilers dripping wet.

His boss comes around every now and then,
"Will you finish soon, and if not when?"
"The bills you know, we must keep down,
For we're not the only shop in town."

New tools and tricks have hurt the trade;
Gas torches and welding machines were made,
No longer 'tis an art to plug
A rivet by hand in its hole so snug.

"Just mash them down and we'll run a bead
Around their heads, that's all they'll need,"
The job's soon over and home we go
A part day's pay for our time to show—

'Tis not the boss's fault I say
That he must give a part day's pay,
The customer is always right
And nowadays they're very tight.

The boss must keep the loss away
And try to make his business pay,
For loss of business reflects on you
Cause we're all partners in the business too.

The trouble then comes from the great gains
In new machines, causing growing pains.
Our lives we believe Uncle Sam will adjust,
We not only believe, but hope he must.

The payroll tax will smooth the line
And perhaps make everything fine.
The machine will be charged for the layoff slack
Perhaps good times will really come back.

GENERAL REFRACTORIES COMPANY announces the appointment of the Bird-Archer Company, Philadelphia, as dealer agents in the Philadelphia area. The Bird-Archer Company will carry a complete stock of refractories.

THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION, Cleveland, has moved from its former address, 1222 Guarantee Title Building, to 10525 Carnegie Avenue.

Questions and Answers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

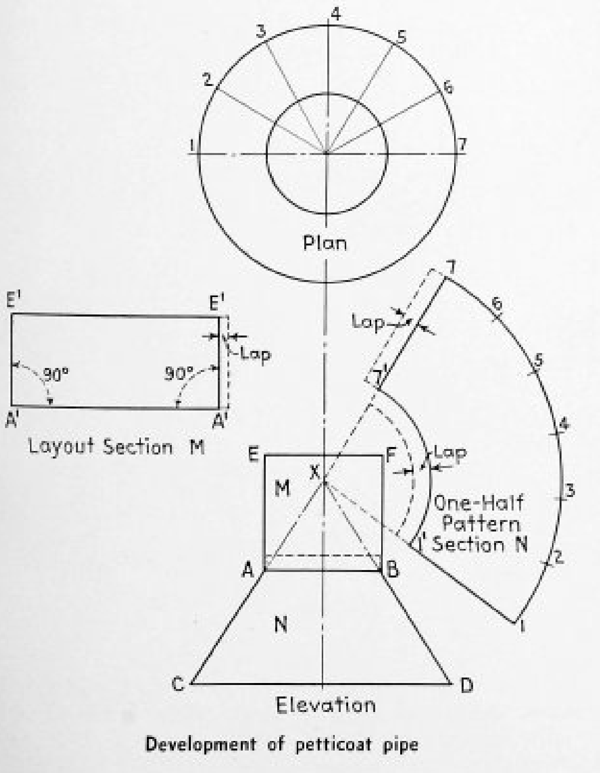
By George M. Davies

Petticoat Pipe Layout

Q.—Would you kindly furnish me with a simple layout of a petticoat pipe with a flared bottom. Bottom to be made in two half sections.—H. M. W.

A.—A solution to this problem is shown in Fig. 1. A full view of the plan and elevation is given, which shows the petticoat pipe to made up of a cylinder *M* and a frustum of a cone *N*. The frustum of a cone section *N* is developed by the radial line method of plate development and is illustrated in Fig. 1.

Construct an elevation of the cone, or at least a one-half view of the elevation. With *X-D* as a radius describe an arc of indefinite length with *X-B* as a radius draw another arc for the upper base *A-B*. From any convenient point, as 1 of the arc for the lower base, draw a radial line connecting with point *X*, cutting the upper arc at the point 1′. On the lower arc and from point 1, lay off the stretch-out for the lower base of the frustum. This may be done with a graduated traveling wheel, or by spacing the arc as shown. These division lengths should equal the arc lengths of the plan.



Development of petticoat pipe

The circumference of one-half the lower base *C-D* equals the product of its diameter multiplied by 3.1416, divided by 2. For example, if the base *C-D*, is 15 inches in diameter, one half its circumference is

$$\frac{3.1416 \times 15}{2} = \frac{47.124}{2} \text{ inches or } 23.562 \text{ inches.}$$

This length is called the stretch-out in pattern work. Having located the point 7, connect it with *X* by the radial line *X-7*. Where this line cuts the upper arc in point 7′, the stretch-out 1′-7′ for the upper base is determined.

Along the stretch-out of the upper arc 1′-7′ and along the side 7-7′ add the required lap completing the half pattern of section *N*.

To develop the pattern for section *M* make *A′-E′* equal to *A-E* of the elevation and make *A′-A′* and *E′-E′* equal to the stretch-out of the upper base *A-B* completing the pattern as shown adding the required lap at one end only.

Pressure for Miniature Boiler

Q.—I desire to comment on an article recently published in Boiler Maker and Plate Fabricator as follows:

On page 23 of the January issue, F. D. H. asks a question. I am wondering if this question has been weighed carefully enough and so I am submitting my views.

F. D. H. states that pressure will be 150 pounds gage, also Mr. Davies in paragraph A-(1) gives the same pressure and both specify a miniature boiler.

I note the Boiler Code under Miniature Boilers, paragraph M-1 gives the definition as "boilers to which the classification 'miniature' applies, embrace fired pressure vessels which do not exceed the following limits: 100 pounds per square inch maximum allowable working pressures."

"Where any one of the above limits is exceeded the rules for power boilers shall apply."

P-17 of the Power Code states minimum thickness of any boiler plate under pressure shall be ¼ inch.

Therefore how can boiler be only 3/16 inch and be classed as a miniature boiler, whereas it is obviously a power class boiler?—C. W. C.

A.—The points brought out by C. W. C. are correct. In answering the specific questions asked, the question of boiler pressure was not considered. It would be well for F. D. H. to note:

(1) The A.S.M.E. Code for Miniature Boilers states

M-1—Definition: Boilers to which the classification "miniature" applies, embrace fired pressure vessels which do not exceed the following limits:

16 inches, inside diameter of shell

42 inches, length of shell

20 square feet water heating surface

100 pounds, per square inch maximum allowable working pressure.

Where any one of the above limits is exceeded the rules for Power Boiler shall apply.

The boiler would therefore come under the Code for Power Boilers which states:

P-17. Thickness of Plate: The minimum thickness of any boiler plate under pressure shall be ¼ inch. The minimum thickness of plates in stayed surface construction shall be 5/16 inch.

P-18. The minimum thickness of shell plates, and dome plate after flanging, shall be for 36 inches or under $\frac{1}{4}$ inch.

P-20. The minimum thickness of tube sheet for fire-tube boilers, shall be as follows:

When the diameter of tube sheet is 42 inches or under—$\frac{3}{8}$ inch.

Checking the specifications given against the foregoing information it will be found that the shell which is to be $\frac{3}{8}$ inch thick is satisfactory.

The combustion chamber if stayed would have to be $\frac{5}{16}$ inch instead of $\frac{3}{16}$ inch thick.

The tube sheet would have to be $\frac{3}{8}$ inch instead of $\frac{1}{4}$ inch as indicated in the specification.

Steel Stack Layout

Q.—The writer outlines below some questions which frequently arise in laying out steel stacks, and will greatly appreciate any information and instruction which you care to give relative to their solution.

Assume, for example, that we are laying out a stack 6 feet in diameter (inside), the lower half of which is to be made of $\frac{5}{16}$-inch plate and the upper half of $\frac{1}{4}$-inch plate.

We are familiar with the method of adding seven times the thickness of the metal to the circumferential stretch-out as allowance for telescoping the courses of the stack, when the courses are of equal plate thickness. The question is how to determine the correct stretch-out of the $\frac{1}{4}$-inch plate at the point where the thickness of the metal steps from $\frac{5}{16}$ to $\frac{1}{4}$ inch.

We should like to have you discuss this problem in three different ways: Assuming that the $\frac{1}{4}$-inch course telescopes over the outside of the heavier plate; inside the heavier plate; and with all joints flush on the outside of the stack as in butt-welded construction.

For question No. 2, let us assume that the bottom of the stack is to be encircled by a band $\frac{1}{4}$ inch in thickness, and this by another band of, say, $\frac{3}{8}$ of an inch in thickness. These bands are to be riveted through the stack with a double row of rivets.

The writer would appreciate some discussion as to the most accurate method of determining the stretch-out length of these successive bands, and of laying out the required rivet holes.—E. A. K.

A.—The question as to the circumferential stretch-out for the telescoping of cylindrical courses is best determined from the experience of the layerout for the particular job in hand. The most accepted practice is the one given in the question, that of adding seven times the thickness of the metal to the circumferential stretch-out, any deviations from this practice are those made by layerouts who have found through experience on their particular problems that this amount is too great or too little.

The recommended practice is as follows:

Where material used in plate construction has considerable thickness, it is apparent that when a plate is rolled up in the form of a cylinder, the diameter at the inside of the plate is less than the diameter at the outside by twice the thickness of the plate. The circumference therefore, corresponding to the inside diameter, will be less than that corresponding to the outside diameter. When laying out the plate neither of these values for the circumference should be used for the length of the plate, as one would be too short and the other too long; but the circumference of a circle whose diameter may be called the neutral diameter or the diameter to the middle of the thickness of the plate, will be the correct one to use. Thus if a $\frac{1}{4}$-inch plate is to be rolled to a cylinder whose inside diameter is *72* inches, the plate must be laid out with a length between the center lines of the rivet holes equal to the circumference of a circle whose diameter is $72\frac{1}{4}$ inches, or if t is the thickness of the material and D the inside diameter, then the neutral diameter is $D + (2 \times \frac{1}{2}t)$ or $D + t$. Therefore the circumference corresponding to this diameter is $3.1416 \times (D + t)$ or $3.1416\,D + 3.1416t$. That is, it is equal to the circumference corresponding to the inside diameter plus 3.1416 times the thickness of the plate. For ordinary work three times the thickness of the plate is generally used. The circumference corresponding to the outside diameter might have been found, in which case three times the thickness of the plate should be subtracted from it.

When two rings or courses of plates are to be joined one of which is an inside and the other an outside ring, the circumference corresponding to the neutral diameter of the inside ring is found first and then for the length of the outside plate, six times the thickness of the metal should be added to this. This will make a close fit between the rings, as the exact amount to be added is twice 3.1416 or about $6\frac{1}{4}$ times the thickness of the material. For an easy fit, add a little more to this. This amount can best be determined from the experience of the layerout for the particular job in hand. In the case of a straight stack, with "in and out" rings, where there is no pressure upon the shell and the work is not to be watertight, seven times the thickness of material can be added to the length of the inside ring to obtain the length of the outside ring. For the particular problen given in the question, I would use the neutral diameter of the individual plates for determining the stretch-out.

1. (a) Where the $\frac{1}{4}$-inch course telescopes over the $\frac{5}{16}$-inch course and the stack is *72* inches inside diameter at the $\frac{5}{16}$-inch course, the stretch-out would be for the $\frac{5}{16}$-inch course.

$3.1416 \times D + t$ or $3.1416 \times 72\frac{5}{16}$ inches.

for the $\frac{1}{4}$-inch course the stretch-out would be:—

$3.1416 \times D + 2t + t'$

where t = thickness of inside course or $\frac{5}{16}$ inch

and t' = thickness of outside course or $\frac{1}{4}$ inch

or $3.1416 \times 72 + (2 \times \frac{5}{16}) + \frac{1}{4}$

or $3.1416 \times 72\frac{7}{8}$ inches.

(b) Where the $\frac{5}{16}$-course telescopes over the $\frac{1}{4}$-inch course and the stack is *72* inches inside diameter at the $\frac{5}{16}$-inch course.

The stretch-out for the $\frac{5}{16}$-inch course would be

$3.1416 \times D + t$ or $3.1416 \times 72\frac{5}{16}$ inches

The stretch-out for the $\frac{1}{4}$-inch course would be

$3.1416 \times D - t'$

where t' = thickness of inside course or $\frac{1}{4}$ inch

$3.1416 \times 72 - \frac{1}{4}$

$3.1416 \times 71\frac{3}{4}$ inches.

(c) Where the $\frac{1}{4}$-inch course and the $\frac{5}{16}$-inch course are flush on the outside as butt-welded construction and stack is *72* inches inside diameter at the $\frac{5}{16}$-inch course.

The stretch-out for the $\frac{5}{16}$-inch plate would be

$3.1416 \times D + t$ or $3.1416 \times 72\frac{5}{16}$ inches

The stretch-out for the $\frac{1}{4}$-inch plate would be

$3.1416 \times D + (2 \times t) - t'$

where

t = thickness of $\frac{5}{16}$-inch course

t' = thickness of $\frac{1}{4}$-inch course

or

$3.1416 \times 72 + (2 \times \frac{5}{16}) - \frac{1}{4}$

$3.1416 \times 72\frac{3}{8}$ inches.

2. In case the bottom of the stack is to be encircled by a band $\frac{1}{4}$ inch in thickness and this by another band of $\frac{3}{8}$-inch thickness. The stack being *72* inches diameter $\frac{5}{16}$ inch thick.

The stretch-out of the $\frac{1}{4}$ inch band would be:

$3.1416 \times D + 2t + t'$

where

D = inside diameter, inches

t = thickness of stack, inches

t' = thickness of band, inches

or

$3.1416 \times 72 + (2 \times \frac{5}{16}) + \frac{1}{4}$

$3.1416 \times 72\frac{7}{8}$ inches.

The stretch-out for the $\frac{3}{8}$-inch band would be

$3.1416 \times D + 2t + 2t' + t^2$

where

t^2 = thickness of outside band

or

$3.1416 \times 72 + (2 \times \frac{5}{16}) + (2 \times \frac{1}{4}) + \frac{3}{8}$

$3.1416 \times 73\frac{1}{2}$ inches.

The rivet holes should be laid out on the stretch-out of each band as obtained above.

The Lincoln Electric Company, Cleveland, announces moving of the Pittsburgh office, formerly at 323 Fourth Avenue, to larger quarters at 926 Manchester Boulevard.

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15 Park Row, New York

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Steel Plate Fabricators Association

President — Merle J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

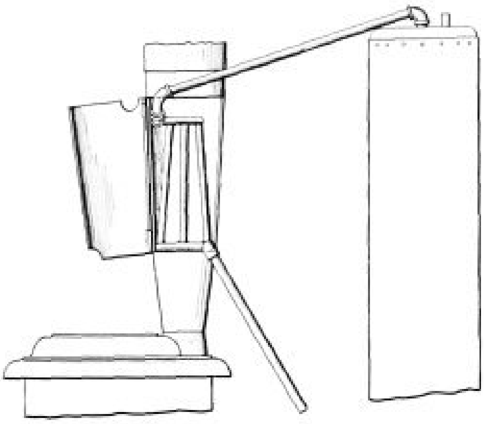
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,897,413. WATER HEATER. GUST ANDERSON, OF ASHTABULA, OHIO.

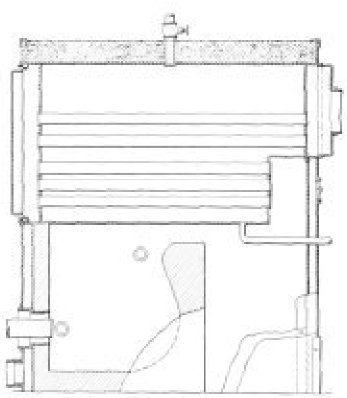
Claim.—In a water heater, an upper manifold, a lower manifold of greater dimensions, and tubular elements having their end portions in



communication with said manifolds, the manifolds providing ducts extending circumferentially, and comprising deflected portions of one continuous tube. Four claims.

1,908,547. BOILER. WILLIAM B. SIMMONS, OF BENNINGTON, VERMONT, ASSIGNOR TO WILLIAM B. SIMMONS, HERMAN McC. SIMMONS, AND FREDERICK M. SIMMONS, CO-PARTNERS DOING BUSINESS UNDER THE FIRM NAME OF B. C. SIMMONS' SONS, OF NORTH BENNINGTON, VERMONT.

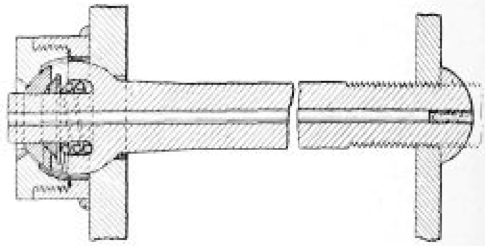
Claim.—A heater comprising a drum for containing water and having fire tubes therethrough, means for supporting said drum with its tubes substantially horizontal, said supporting means including a pair of spaced



end walls, the inner of said walls having its upper edge terminating at said drum, and the outer of said walls extending across the end face of said drum and having an opening through which access may be had to the ends of said tubes, a cover for said opening spaced from said tube ends and having a marginal flange removably secured to said drum and outer wall around said opening, and insulating material extending over said drum and to the outer of said end walls. Twelve claims.

1,910,215. TELL-TALE FLEXIBLE STAYBOLT. FREDERICK H. EINWAECHTER, JR., OF WEST HALETHORPE, AND ALBERT E. ANGER, OF GARLAND PARK, MARYLAND.

Claim.—In a pivot head structure for staybolts, and in combination with a bolt head casing having inner and outer walls provided with alined openings and partly spherical seats about said openings, a bolt body provided with a tell-tale opening extending there through from end to end thereof and having an end portion projecting through the said openings in the walls of the casing, said end portion of the bolt embodying a substantially hemispherical inner head member presenting a convex pivot face engaging the seat in the inner casing wall and a straight transverse outer face, an extension of reduced diameter with respect to the bolt body



projecting beyond the transverse face outward through the opening in the outer casing wall, an apertured outer head member slidably engaging said bolt end extension and having a convex outer pivot face engaging the seat in the outer casing wall and a concaved inner face, the convex faces of said head members being arranged on arcs of one and the same circle so that said head members co-operate to form a pivot head of spherical outline for universal pivotal motion of the bolt on said seats, a packing member slidably engaging the bolt end extension and having an outer convex face engaging the concaved face of the outer head member, a washer about the bolt end extension and backing the packing member, and a spring disposed between the inner bolt head member and the packing member and operating to yieldingly press the outer bolt head member and packing member outwardly. Two claims.

POSITION WANTED

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Boiler Maker and Plate Fabricator

Fabricated Steel Plate Orders Above Last Year

The Bureau of the Census report on fabricated steel plate orders for the month of February shows a considerable decline in demand for that commodity. The year opened rather auspiciously with a total of 38,709 short tons ordered for January, which was a new high for that month since pre-depression days. In February, a decrease in orders of 10,879 short tons occurred, which is approximately a 28 percent change from the previous month. However, the past two years have both shown downward trends during this month and the February, 1936, total is still 85 percent greater than the same month a year ago and 90 percent greater than February, 1934.

Of the components making up the total, oil storage tanks showed a considerable increase along with refining equipment and material, but gas holders, tank cars, blast furnaces and miscellaneous items all contributed rather heavily to the decline. A survey of reports of the past three years indicates, however, that a pick-up in the number of orders may be anticipated for the spring and increasing activity in the heavy industries may also have served to encourage this movement.

Boiler Industry Continues Improvement

The latest returns on orders for steel boilers, compiled by the Bureau of the Census, Department of Commerce, show that business improvement, begun last fall, has continued at a healthy rate through February. This condition is in contrast to the previous two years, when the trend of orders has been downward during the winter months and continuing until early spring.

Analysis of the actual figures shows that a grand total of 705 steel boilers was ordered in February 1936, which is a 10 percent increase from January and a 237 percent increase from a year ago. Comparison of the heating surface over the same periods reveals a 30 percent increase in the month and a 286 percent increase from February 1935.

A further breakdown of the returns into power boilers and heating boilers indicates that the power boiler field contributed most to the general improvement, as heating boilers declined slightly and marine boilers, although showing some improvement, occupy too small a position in the industry just now to cause much effect. In February, 233 power boilers were listed as ordered, as compared with 175 for January and 127 for a year ago. The changes stated in percentages are 25 percent for the month and 83 percent from the same month of 1935. At the same time, the increase in heating surface for power boilers was 29 percent, which illustrates the trend of business to the construction of larger units.

While the orders for heating boilers are superior numerically, the heating surface areas for power boilers constitute about 65 percent of the total. This is shown in the comparison of the figures for these two types. The number of heating boilers ordered in February was 453 units, with 209,172 square feet of heating surface, as compared with 233 units of power boilers with 538,525 square feet of heating surface.

If the present optimism continues, as measured by the amount of new orders, and the behavior of the industry follows the same general trend as previous years in improvement during the spring and summer, the combination of these two factors should bring, in the coming months, more business than has been enjoyed for years.

The mechanical stoker industry continues its seasonal decline from the peak of September and October last year. Present indications are that the trend of orders for the larger industrial stoker types should soon begin to improve, followed closely by the general commercial and medium capacity machines.

Shop Problems of Streamlining Locomotives

The extension of streamlining to the steam locomotive has opened a new field for the railway boiler shop. While only in its inception, this method of promoting efficiency of motive power and improving appearance will unquestionably find an increasing application as present passenger and even freight locomotives are modernized or new ones built.

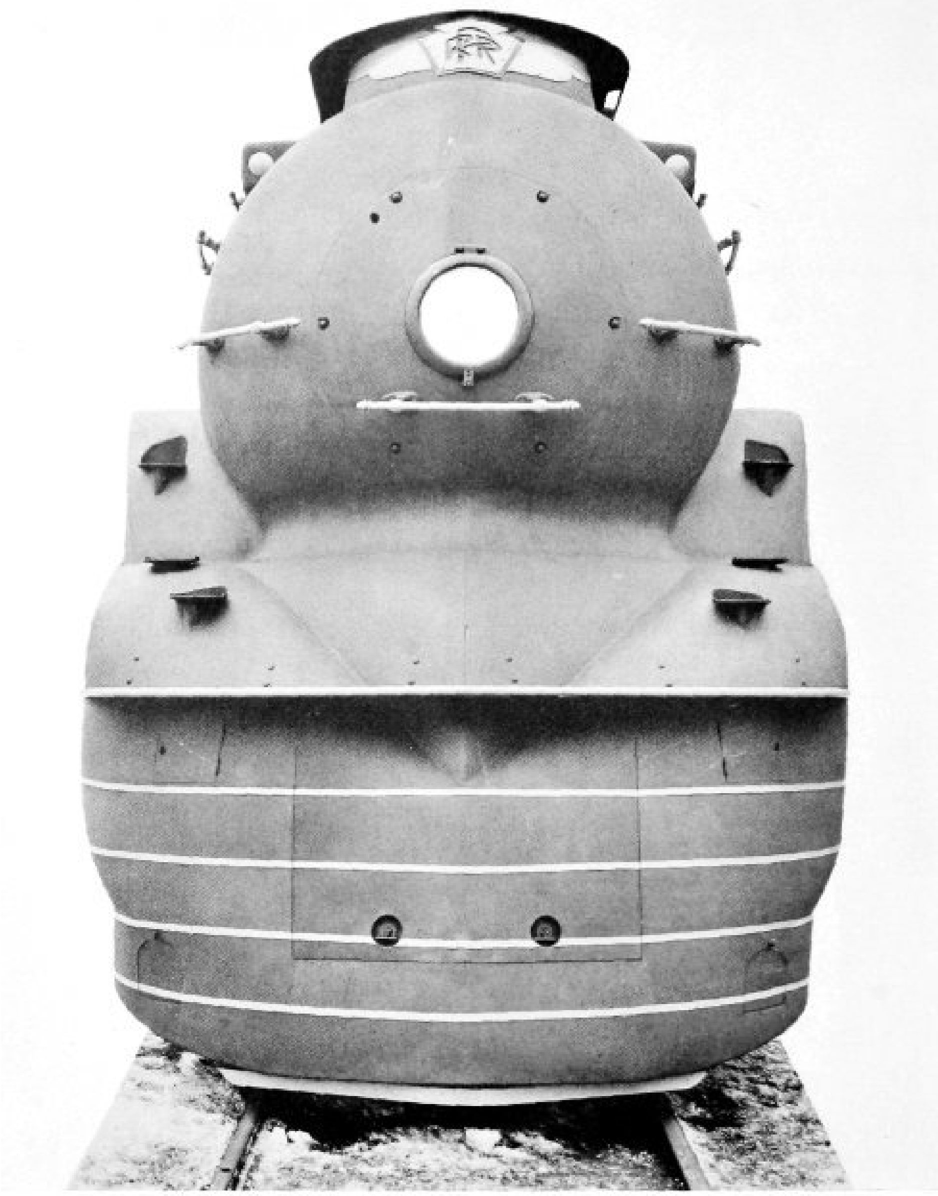
First came the New York Central with its rebuilt streamlined *Commodore Vanderbilt*. Then the Milwaukee brought out two new engines of the *Hiawatha* class. Recently the Pennsylvania rebuilt a Class K4s, Pacific passenger locomotive at the Altoona shops which embodies the most striking streamline principles yet evolved. Details of the work of designing and building the casing appear in this issue. Finally the New York Central has produced another example of streamlining at the West Albany boiler shop. This last locomotive has been sent on the road to haul a special advertising train for commercial drug products.

As yet these isolated cases of a new job for the boiler shop can only be cited to indicate a trend. It may be predicted, however, that practically all of the railroads in some form or other will adopt this method of improving appearance as the funds become available to carry out their plans for the modernization of equipment. It is essential that the steam locomotive be not overlooked in this respect, for not only is it a practical method of showing the application of progressive ideas but is very necessary in view of the development of the modern high speed Diesel train, which is changing the traveling public's conception of rail transportation.

Both the Pennsylvania and the New York Central will undoubtedly go ahead rapidly with the conversion of other locomotives on through passenger service.

All this leads to the problem thus created for boiler

(Continued on page 98)



The Pennsylvania's conception of effective streamlining

Locomotive Streamlining Makes Progress

The Pennsylvania has recently turned out from the Altoona shops a Class K4 Pacific type locomotive and tender which has been completely streamlined by cowling over the boiler and skirting which extends down from the running board and around the front of the locomotive. The cab is faired into the lines of the locomotive, and the tender has been made to continue the lines of the locomotive by curved sides above the top of the tender, which conform to the sides of the cab roof. The top of the tender is not enclosed. The bottom of the skirting and tender form an unbroken line with the bottom of the coach sides when the locomotive is coupled to a train.

An outer diaphragm of heavy sheet rubber closes the space between the front of the tender and the rear of the cab, which is entered by side doors at the gangway behind the enginemen's seats. This diaphragm, which is put up under tension, provides a smooth, continuous surface between the engine and tender while standing on straight track, and stretches as much as is necessary to conform to the relative movement between the engine and tender on curves.

The body color is a gun metal tone against which the triping stands out sharply. The letters and the stripes n the tender and around the cab windows are in gold. The stripes on the engine are stainless steel, as are also he handrails on the sides and front end and the winged eystone emblem on the cowling in front of the stack.

By the separation between the front end of the boiler nd the skirting in front of the pilot and around the ylinders the characteristic appearance of the steam locomotive has been retained. Aside from its pleasing appearance this separation is said to reduce the tendency o develop low-pressure pockets along the sides of the oiler at the front of the cab, which is characteristic f the so-called shovel-nose form.

The smoke-lifting device consists of the stack cowlng, enclosing a space of considerable width at the sides f and behind the stack, which is closed at the top by a orizontal plane flush with the top of the stack and xtending somewhat beyond the cowling at the front and ides. Along each side of the boiler, starting with the nclosure for the classification lights at the front is a lane, the lateral elements of which are horizontal, which lopes upward toward the rear and blends into the conour of the cab roof. The space between each of these lanes and the under side of the projecting horizontal lane is thus narrowed toward the rear, tending to produce a slight increase in air pressure and velocity at he rear end of the horizontal plane. This is said to emove all tendency for smoke to trail along the top f the boiler and the lateral component of the increased ressure in the air stream between the two planes is also a factor in reducing low-pressure spots along the side f the boiler toward the front of the cab.

The front end of the locomotive is completely equipped with a coupler and both brake and signal hose connecions. When not in use the coupler is swung back horiontally and the hose connections are dropped into place ehind the contour of the skirting which is closed by a anel permanently attached to the locomotive and which moves up and back within the skirting when opened.

The boiler cowling and cab are fabricated of sheet steel. The skirts below the running boards are of aluminum sheets. A long panel of each skirt is arranged to be completely removed by removing a few bolts when access to the rods and motion work is required in the engine house or shop. Doors have been provided at points where access for lubrication is not otherwise available. The smokebox and smokebox front have been lagged to protect the cowling from the heat. Openings in the cowling are provided over the whistle and pops, the location of which has not been changed.

The tender has 18,000 gallons capacity. The water tank is provided with two longitudinal filling holes, one in each side. The panels in the curved extensions of the tender sides opposite these openings are arranged so they may be unlatched and rolled laterally toward the center of the tank to clear the filling holes.

The locomotive as altered has a weight in working order of 337,850 pounds and the weight of the tender loaded is 289,700 pounds. The overall length is 95 feet.

The design of the streamlining was developed by the railroad's engineering department in co-operation with Raymond Loewy, New York, an authority on streamlining and a member of the road's technical advisory staff. In working out the final design, tests were carried on over a period of months in the wind tunnel of the New York University aerodynamic laboratory. Instead of the usual type of wood or metal models, clay models were used for the first time in these experiments. They demonstrated their superiority over the other materials because of the readiness with which shapes could be altered immediately upon observing the results of each test. Observations of air flow were made by the use of both silk threads and smoke bombs.

The comparative wind-resistance tests were made with models of the locomotive, tender and one coach. Under these conditions at wind-tunnel speeds of 100 miles per hour, the air resistance was reduced from 896 horsepower with a conventional locomotive to 600 horsepower with the streamliner.

Locomotive and tender rebuilt at Altoona shops, embodying latest streamline principles

Milwaukee provides plant for

SCRAPPING LOCOMOTIVES

Locomotives waiting to be scrapped

Equipment retirement plan will call for continuous program of dismantling cars and locomotives at Dubuque, Iowa, central plant for entire system

During the past year the Chicago, Milwaukee, St. Paul & Pacific has been carrying on an extensive car and locomotive dismantling operation at Dubuque, Iowa, where 150 machinists, boiler workers, car men and other employees are engaged in destroying cars and locomotives sent there from all points on the system. Under the program 8537 freight, work and passenger cars and 421 locomotives were authorized to be dismantled in 1934 and 1935 and it is anticipated that approximately 2500 cars will be handled in the same manner annually during the next five years. Thus far, 3500 cars and 121 locomotives have been dismantled at the plant, the rate at present being 12 cars and one or more locomotives per day.

The establishment of the plant is the last step in a program which has been under consideration since 1931 and has had as its objective the orderly retirement of freight cars which have become obsolete or which can no longer be maintained economically. As early as 1928 a study was made of every type of car owned and, with the aid of cost records, schedules were prepared which prescribe a limit on the amount which may be expended to continue each car in service and which provide that, when this allotment will be exceeded in repairing any of the cars in question, it will be withdrawn from revenue service.

The Dubuque shop was selected as a place reasonably close to the scrap market where the work could be carried on without interfering with other work and without requiring extensive additions or rearrangements of facilities, and also where the dismantling could be performed effectively by former employees. While situated on a secondary line, Dubuque is within a few miles of a

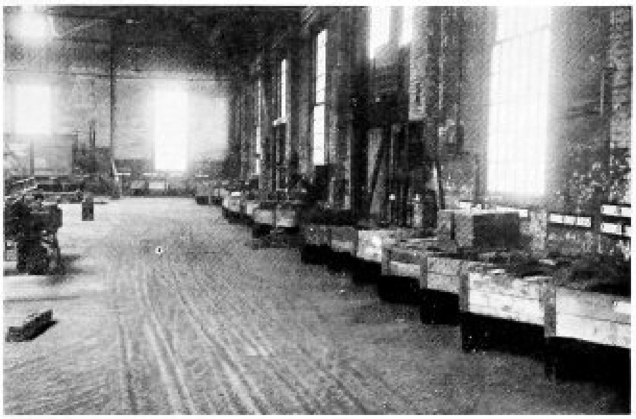
After the boiler has been removed the cylinders, running gear and driving wheels are dismantled unction with two main lines and also at a point where it necessary to maintain switch engines for other purposes.

The facilities consist of an old tank repair shop, 75 eet wide and 170 feet long, containing 9 tracks; an old oach shop of the same size, containing 10 tracks; a ransfer table serving these two shops and 20 or more racks, half of them running parallel to the main line here they were once laid to serve the shops, and the alance following the river bank where they were once id for storing cars. The land between the two sets of racks was cleared of old sheds, cross-overs were installed in the dismantling tracks, and a new building was onstructed for generating acetylene and distributing xygen and acetylene to outlets installed throughout the ard.

This oxy-acetylene plant, designed by the Air Reduction Sales Company, is one of the largest in use on a raiload. It consists of a brick and concrete building 26 feet ide and 50 feet long, with one room containing two irco oxygen manifolds, each holding 20 cylinders for a ombined production of 30,000 cubic feet of oxygen per ay under 35 pounds pressure, a second room for storing arbide, and the third containing three Airco-DB acetyene generators holding 300 pounds of carbide each. This uilding has a concrete floor, metal doors, and each a orrugated steel roof, vapor-proof lights, ventilators in ne room and at floor level, and has a shipping platform arfloor high on one side.

The facilities provided include trays for collecting and hipping material by means of power units which handle ne material around the plant. A steam wrecking crane available for use in the boiler and dismantling yard for oading uncut boilers or performing other heavy work. pparatus has been installed for removing tires and reovering the lead in the counterbalances of wheel centers.

Car dismantling is carried out in the shop itself, while ismantling of locomotives and tenders is independent f the car work and is all performed outside. The locoiotives are dismantled on one track, the cranes working n a parallel track and loading the scrap into cars on a ird parallel track. Other tracks are used for storing comotives awaiting dismantling and for handling tender ork. Usually two locomotives undergo dismantling at ne same time, during which they are removed progressively from one end of the track to the other. In the first position the piping and fittings and front end are removed and the cab is lifted and burned on adjacent property. The locomotive is then moved to the second position where the jacket and lagging are removed and laid to one side in containers. In the same location the barrel of the boiler is reduced to four pieces by making two cuts around the shell and cutting lengthwise just above the belly sheet. This metal is immediately loaded into a car, the flues into another car, and the back end is loaded uncut into another car. If the boiler is small, it is sold uncut.



Materials to be repaired or held for further inspection are deposited in bins along the shop wall

The locomotive is then advanced to another position forward where the frame and running gear are reduced to scrap by oxy-acetylene cutters and loaded into cars. The cylinders are completely dismantled in this operation. The locomotive is then moved to the next position for dismantling the wheels. The driving boxes, if of steel, are removed and laid aside for shipment to Milwaukee, together with leaf springs and other articles subject to repair or further inspection. If the tires are worn out, they are cut free from the wheels, and the axles are then cut. Wheels with good tires are placed horizontally on a block and the tires removed with a

Cutting up underframes and center sills is an important part of the work in the North Shop

heater ring and fuel oil; the wheel centers are next placed in an improvised forge and the lead in the counterbalances melted and collected into molds for re-use.

Meanwhile, on nearby tracks, tenders are cut loose from the underframes, dumped on the ground and cut into heavy melting steel, and the trucks moved by a lift truck into the shop for dismantling. Locomotives are being dismantled and the materials disposed of at the rate of seven or eight locomotives per week, using a force of nine cutters, eight laborers and two crane operators, working one shift.

Detailed costs of the Dubuque operation are prepared each month from daily reports of the equipment dismantled and from expense accounts for labor and material, and, by time studies. It is estimated on the basis of shipments made that 95 percent of the locomotives are reduced to scrap and 60 percent of the metal in cars. The remaining 40 percent includes materials retained at Dubuque for further use, also mounted wheels, brake beams and other materials shipped to Milwaukee for repair or sale when inspected and separated.

The cost of the operation includes all charges for supervision, labor and material at Dubuque, and all switching charges and expenses for heat, light and power, but excludes taxes and other overhead on the property. The cost covers dismantling, preparation of scrap for sale and the handling of both scrap and serviceable material. The combined cost of dismantling and handling in June, 1935, when 9027 tons of metal were handled, was $1.96 per ton. The figure includes 71 cents per ton for dismantling, 85 cents for cutting scrap, and 40 cents for loading and sorting this scrap. Of this the labor cost was $1.35 per ton. The cost in June of dismantling and handling material from 482 freight cars, containing 6602 tons of metal, was $1.82 per ton, consisting of 47 cents for dismantling, 93 cents for cutting scrap, and 42 cents for loading and sorting scrap. Of this the labor cost was $1.31 per ton. The cost of dismantling and handling the material from 20 locomotives with 1873 tons of metal in June was $2.28 per ton, consisting of $1.46 per ton for dismantling, 49 cents for cutting, and 33 cents for loading and sorting the scrap. Of this the labor cost was $1.34 per ton.

Electric Arc Used to Construct Water Scrubber

Approximately 72 tons of steel plate was recently fused together into one integral piece of steel in construction of the water scrubber shown in the accompanying illustration. The vessel shown is 8 feet in diameter and 72 feet 4 inches in length. The plating of the shell is $1\frac{9}{16}$ inches thick, that of the head $1\frac{7}{8}$ inches. The six supporting feet are each composed of three pieces of steel plate fused together by the electric arc and welded to the tank. After welding, the vessel was tested to 450 pounds per square inch pressure. It was built by the Treadwell Construction Company, Midland, Pa., for export shipment. The welding was done with shielded arc equipment supplied by The Lincoln Electric Company, Cleveland, O.

Boiler Horsepower

By W. F. Schaphorst

Considerable confusion exists in the minds of some boiler manufacturers regarding this relationship between a boiler horsepower and the horsepower of an engine.

Surprising as it may be, a boiler horsepower is 13.2 times as great as a mechanical horsepower. Here are the actual figures:

One boiler horsepower = 33,479 British thermal units per hour.

One mechanical horsepower = 2544.6 British thermal units per hour.

The reason for this great difference is that in the early days when boilers and engines were first made and used a 100-horsepower boiler was called a 100-horsepower boiler because of its ability to supply enough steam to run a 100-horsepower engine. And so on.

Boilers are much more efficient now than they were in the days of James Watt. There has been so pronounced an improvement that today a 100-horsepower boiler will easily take care of a 250-horsepower engine. Engines have improved also but not to the extent that boilers have improved. And that is why the old relationship no longer holds. But it is nevertheless a fact even today that a boiler horsepower, according to the modern definition of a boiler horsepower, is 13.2 times as great as a mechanical or engine horsepower.

It is evident that in the "old days" when one boiler horsepower produced one mechanical horsepower the efficiency of conversion was only 1 ÷ 13.2 = 7.6 percent. In other words, only 7.6 percent of the heat energy in the steam was converted into work. Today the best plants show efficiencies that are much greater. According to my files the highest reported is 27 percent.

Water scrubber weighing 72 tons, 8 feet in diameter and over 72 feet long, fabricated by arc welding

Silver medal award to boiler makers

Examinations for British Boiler Makers

By J. W. Thompson

The following I think would be of interest to the readers of BOILER MAKER AND PLATE FABRICATOR. It is a brief survey of the Final Examination in Boiler Makers' Work which is held in the local Technical Colleges under the direction of the City and Guilds of London Institute Department of Technology.

The examination is an annual one occurring in April or May. An entrance fee of 6 s/- is required before one is allowed to compete in the examination. If a candidate is successful he is either awarded a First Class or Second Class certificate depending upon which he has qualified. For the best result of the whole entrants, and I might say that it is open to all the British Empire, a Silver Medal is awarded, a most coveted prize in the boiler making fraternity. I enclose reproductions of one of these medals showing both sides, which the writer of this article won.

Below is the examination as held last May.

Boiler Makers' Work Final Examination

INSTRUCTIONS

The number of the question must be placed before the answer in the worked paper.

A sheet of drawing paper is supplied to each candidate as well as drawing instruments to be used in this examination. The candidate is recommended, wherever practicable, to illustrate his answers by drawings or diagrams. Except where otherwise specified, these may be in freehand, and however rough, provided they clearly indicate what is on the candidate's mind they will be duly credited to him equally with the written answer to the question.

Candidates must keep the parts of an answer in the same order as the parts of the corresponding question.

Three hours allowed for this paper.

The maximum number of marks obtainable is affixed to each question. Not more than eight questions to be attempted.

Question 1. What do you understand by the term "percentage strength" of a riveted joint? What are the "percentage strengths" of the rivets and plate in a treble riveted butt strapped joint in which the rivets are pitched 6 inches apart in the outer rows and 3 inches in the inner rows? All the rivet holes are $^{15}/_{16}$ inch diameter and the plate and butt straps are $3/4$ inch thick. State the tensile strength of the plate and the shearing strength of the rivets which you have assumed in your calculations. (45 marks).

Question 2. Describe a method of controlling the temperature of superheated steam (a) in a superheater placed behind a Lancashire boiler, and (b) in the integral superheater of a watertube boiler. Of what materials should the pipes and the various parts of valves passing superheated steam be made? State the reason for employing such materials. Why is it considered generally necessary to fit safety valves to superheaters fixed behind Lancashire boilers? (40 marks).

Question 3. In boilers fed with sedimentary feed waters, what is the effect of scale or sediment if allowed to accumulate (a) on the efficiency and (b) on the life of the boiler? Describe in detail how these effects are produced, and the kind of defects which may result in an internal furnace tube, in a smoke tube and in a watertube. (35 marks).

Question 4. Describe in detail a sliding expansion joint such as is frequently employed in long straight steam pipes. Do you know of any objection to such joints? Describe an alternative method of taking up the expansion of steam pipes and make a sketch of a pipe 100 feet long showing the position and type of the provision for expansion and the number and position of the supports. Show by a separate sketch the details of the supports. (40 marks).

Question 5. How does the thermal efficiency of a boiler vary in relation to the steam output? What effect has the rate of working on the temperature of escaping gases? What, approximately, is the temperature of the flue gases leaving (a) a marine type boiler and (b) a Lancashire boiler? A boiler in which coal is burned having a calorific value of 14,500 British thermal units is found to be evaporating 9.25 pounds of water from and at 212 degrees F. per pound of coal. What is the thermal efficiency of the boiler? What can you ascertain about the efficiency of the furnace by an examination of the escaping gases? (50 marks).

Question 6. Describe briefly so as to indicate the essential differences a lever safety valve, a dead weight safety valve, and a direct spring loaded safety valve, and say for what types of boiler you would consider each of these valves suitable. In a direct spring loaded safety valve describe the method adopted to counteract the increasing resistance of the spring as the valve lifts under pressure; describe also the means of limiting the load on such a valve so that it may not be inadvertently overloaded. What do you consider would be a reasonable increase of pressure to allow during the period of discharging, above that at which the valve is adjusted to commence blowing? (50 marks).

Question 7. The front end of a marine type boiler is badly corroded internally in the narrow portion between the furnace tube and shell, and the defective part for a length of 2 feet has to be cut out and a repair plate fitted in the same thickness as the end plate. The end plate is flanged inwards for attachment to both shell and furnace tube. Describe in detail how you would proceed to effect this repair and show the method of making the end joints. What men and equipment would you require, assuming the repair to be made without removing the boiler from the vessel? (50 marks).

Question 8. The back of a marine boiler combustion chamber is inclined to the end of the boiler. Show by a sketch how you would insert the stud stays between the two plates; the stays to be fitted with a nut at both ends. The combustion chamber plate being ¾ inch thick and the working pressure 200 pounds per square inch, calculate how far apart the stays must be spaced, the diameter of the stays, and the number of threads per inch. Your figures must indicate how your particulars have been arrived at. (45 marks).

Question 9. In the longitudinal joint of a cylindrical shell made with double butt straps what are the factors on which steam-tight work depends? Describe the machinery by which the curvature of the plate is carried right to its ends so as to avoid any flat or irregularity at the butt. What might be the effect on the joint if this precaution were not observed? It is assumed that the rivet holes are all drilled through the three thicknesses after the plates are bent and bolted together. (35 marks).

Question 10. What do you understand by "water hammer" in steam pipes? What danger is to be apprehended from it? How does it arise? Describe an arrangement of steam pipes in which water hammer could occur, when is it likely to occur, and what precautions would you adopt to avoid it (a) in an existing steam pipe installation and (b) in designing a new installation. (40 marks).

Question 11. What is hard feed water? Distinguish between temporary and permanent hardness. State how you would treat hard water (a) in the boiler itself and (b) in a water softener. In either case what would be the condition of the water in the boiler after a long period of working, if there were no blowing out or scumming during that period, and in the case of (a) of what should the deposit in the boiler consist if the treatment has been correct? In the case of treated water, what is likely to occur in the boiler if blowing out or scumming is neglected over a long period? (50 marks).

Question 12. Of the steel used in boiler construction, explain what is meant by "welding quality," what parts of boilers would be specified to be of this quality? Describe the test pieces by which the quality of the plates is determined and state how the strength and ductility of the plate are indicated. It is usual to stipulate that one of the test pieces for bending shall be heated to redness and then quenched in tepid water. What is the object of this? In addition to mechanical tests of steel plates, what other test is usual? (35 marks).

New Streamline Locomotive Sets Speed Records in Germany

By G. P. Blackall

Following some months of experimental operation, in the course of which 118.9 miles per hour was achieved, the Borsig streamlined 4-6-4 locomotive of the German National Railroads has set a new record. On February 27, when hauling a 400-ton train from Hamburg to Berlin, it attained 120 miles per hour. The distance of 178.1 miles was covered in 145 minutes, at an average overall speed of 73.6 miles per hour.

The 4-6-4 wheel arrangement was adopted to provide good weight distribution, room for a large boiler and firebox, and a steady riding locomotive. The locomotive is a simple engine as compounding is not advantageous for high-speed work. The cylinders are 17¾ inches diameter by 26 inches stroke, and drive coupled wheels of 7 feet 6½ inches diameter. The inside cylinder drives the first coupled axle and the two outside cylinders drive the second one. Steam distribution is effected by piston valves which are driven by Heusinger valve gear. The link of the inside cylinder valve gear is driven from the second coupled axle.

The center line of the boiler, on account of the 7-foot 6½-inch driving wheels, is 10 feet 4⅞ inches above the rails. Owing to the 6-foot 1-inch diameter of the boiler, it was impossible to mount the dome on the boiler in the usual manner, and it had to be riveted on the inside. Steam leaves the superheater at 770 degrees F.

The following are the boiler details:

Boiler pressure	284 pounds per square inch
Heating Surface:	
Firebox	200 square feet
Tubes	1629 square feet
Flues	925 square feet
Total evaporative	2754 square feet
Superheater	968 square feet
Total heating surface	3722 square feet

The firebox is of copper, with a grate area of 50 square feet. The firebox heating surface is 200 square feet, and 24 flues of 6$\frac{7}{16}$ inches diameter provide a heating surface of 925 square feet, while 106 tubes of 2¾ inches diameter add another 1629 square feet. The length of the tubes is 23 feet, and the total heating surface is 2754 square feet. In each flue tube are six superheater tubes of ⅞-inch diameter with a total surface of 968 square feet. The boiler will deliver about 33,000 pounds of steam per hour, and the locomotive is estimated to be capable of 2800 horsepower.

In view of the large boiler output the tender has a water capacity of 9780 U. S. gallons and a coal supply of 10 tons, and is therefore carried on five axles.

The new locomotive cost approximately $65,000.

Marine industry extends use of

Welded Piping and Pressure Vessels*

By James W. Wilson†

The trend to higher pressures and temperatures in the marine field is ever increasing; the highest pressures on American vessels now in operation being 450 pounds per square inch, the total temperatures ranging from 700 to 750 degrees F. Recently, designs have been approved for an installation operating at 550 pounds and a total temperature of 800 degrees F. One of our leading shipyards is now working on designs for a ship which is intended to operate at 1200 pounds and a total temperature of 850 degrees F., hence the necessity for improved methods of fabrication in which fusion welding seems destined to displace existing methods of construction.

Welded boilers and pressure vessels have been approved by the Bureau of Navigation and Steamboat Inspection for the past year, several boiler installations have been made and are operating successfully. No difficulty has been experienced in their manufacture or operation, and no work has had to be rejected. Moreover, a number of welded unfired pressure vessels, such as fuel oil and feedwater heaters, evaporators, separators, etc., have been installed, and it is gratifying to note that, as in the case of the boilers, no difficulty or defects have been detected. The record to date reflects great credit upon the manufacturers of such equipment for their cooperation in endeavoring to furnish dependable products. From my experience, I have no hesitation in saying that the shipowners and shipbuilders who have pioneered in the introduction of welded equipment in the marine field are very enthusiastic about its performance under service conditions, and in my contact with them I am advised that when new equipment is ordered, welded construction will be specified.

At the present time there is an insistent demand and urgent need for extending this boiler code to include high pressure piping, that is, piping subject to boiler pressures and temperatures. The code as it now stands permits welded piping for 100 pounds per square inch only. The successful use of welded boilers and pressure vessels, together with the fact that experimental work has been done along these lines, seems to justify the development of a code for the welding of high pressure piping in position on shipboard. The Committee on Welding in Marine Construction is at present giving this matter careful thought and study, and in the near future meetings are to be held to attempt to get together on a safe and dependable code.

It is a fact that many large power stations ashore are operating successfully with welded piping on heavy pressure lines, but one point that cannot be ignored is that marine piping is subjected to a harder usage than is piping in stationary plants. All marine engineers will agree on this point, for not only are there the usual stresses of pressure, temperature, expansion and contraction, and vibration, to contend with, but also the indeterminate stresses placed upon the piping due to the pitching and rolling of a vessel in a seaway, which impose severe twisting, buckling, bending and pulling stresses, or to the impact resulting from a grounding of a vessel. Therefore, the subject is one that must be approached with extreme caution. Another difficulty to be dealt with is the fact that two of the major safeguards of fusion welding have to be sacrificed in its application to piping, namely, the X-raying of the welded joints to determine their soundness, and the stress-relief of the piping under ideal conditions in an annealing oven.

The only precedents covering the use of welded marine piping of which I have any knowledge are the piping on the steamship *Dixie* and on certain modern liners built for the Grace Line. Let us consider the case of the *Dixie* first. On October 21, 1935, I made a survey of this vessel, which recently grounded in a hurricane on French Reef in the Florida Straits, and found that, although this vessel has been in continuous service for a period of 10 years and the stresses placed upon the piping while the vessel was being pounded on the reef were terrific, nevertheless the piping remained intact; not a weld cracked.

It may be well to describe briefly the type of joint used on the *Dixie*. It is a combination screwed thread and welded joint, the end of the pipe being screwed into the flange and the lip of the flange being welded to the wall of the pipe. The welding was done by the gas process and was supervised by the experts of one of the large acetylene welding companies.

The piping on the Grace Line ships previously referred to comprised the astern inlet pipes to the turbines only. These pipes were welded by the butt-weld method, some by the gas welding process and others by the electric-arc process. The welding was performed in the shop in accordance with the A. S. M. E. code requirements for Class I welding, it being possible in this case to X-ray the welds. This piping has been in service for about four years without trouble of any kind.

It is my thought that, in developing such a piping code, drastic qualifying tests should be prescribed for the welding operators; that special attention should be given to the selection of welding rods, and that only the best quality of high test welding rods should be permitted. It might be necessary for the bureau to establish an approved list of welding processes and procedures to insure safe welds. It should be the aim of the committee to endeavor to secure welded joints which would have as nearly as possible the physical characteristics of the base metal. The test specimens should be welded in position without turning the pipe, welds being made vertically and horizontally. The tension test specimen should be tested in the full section of the pipe, particular attention being given to securing complete penetration. It would be most desirable if some reasonable means could be devised as a substitute for the X-rays to determine the soundness of the joints. It is my belief that all of these features will be carefully considered by the committee and that from the study and research that have been made it will be possible to develop a safe and dependable code for the welding of high pressure piping.

* Abstract of paper presented at the 36th Annual Convention of the International Acetylene Association, Cleveland.

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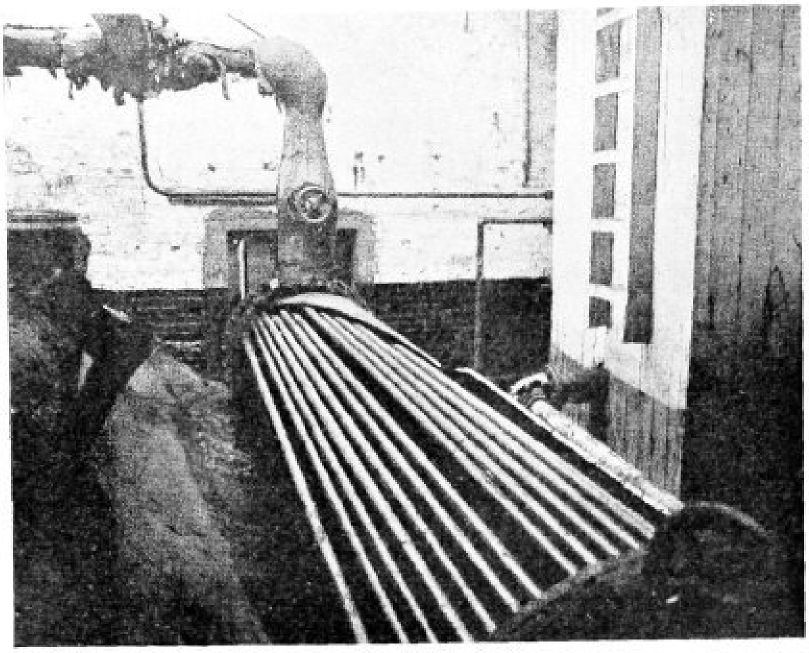

Fig. 1—Failure caused by unsound weld

New method proposed for testing metal in fusion welded joints

Inspecting Fusion Welded Seams in Unfired Pressure Vessels

By William D. Halsey*

The suspicious attitude toward fusion welded pressure vessels that has been very prevalent in the past and exists in some degree at the present time has resulted because of failures of such vessels, which in many cases have caused extensive property damage, loss of life and personal injury. In reviewing those accidents it may be said that, in general, they were caused by unsound welds. The term "unsound" in this connection relates not to weld metal of poor physical properties, but to a fusion-welded joint in which the weld metal was not properly fused to the base material. In other words, there was no adequate bond between the weld metal and the plate.

It should not be understood that failures have never occurred because of poor weld metal. For proper distribution of the stresses in a welded joint, the weld metal should have approximately the same physical properties as the base metal. This requirement is particularly true as regards ductility, since the stresses resulting from the cooling of a molten mass of metal, as in a weld where movement is restricted by the adjoining rigid material, are severe and if cracking of the weld is to be avoided, it is essential that the weld metal have ductility. As a matter of fact the welding of heavy walled pressure vessels was not feasible from a practical standpoint until the advent of the high ductile weld metal available today.

With any of the usual methods of welding now in use, weld metal of adequate tensile strength will be obtained if the weld is sound, that is to say, is free from slag, and is reasonably clean. Some methods of welding may produce joints of higher tensile strength than others, but with the factors of safety in common use the tensile strength of the weld metal itself is of comparatively minor interest.

On the other hand, weld metal of adequate tensile strength and ductility will be of no value if that metal is not properly fused to the base material. Illustrations almost without end could be given of fusion-welded vessels that have failed. An examination of such failures has almost invariably shown an unsound weld, that is to say, one that was not fused to the base metal either because of a mere casting of the metal in the welding groove or because of slag being entrapped between the weld metal and the base material. An illustration of one such failure is shown in Fig. 1. The vessel in this case was a fusion-welded brine cooler in an ammonia refrigerating

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system. The vessel was 42 inches in diameter and 16 feet long. It had been in service for about twelve years when it suddenly tore through the fusion-welded longitudinal seam. From the information that was subsequently obtained, failure apparently took place at very little more than the normal working pressure, causing property damage of $8000, killing one man and injuring two others.

After the accident, specimens were cut from the longitudinal-welded seam, polished and etched. These etched specimens are shown in Fig. 2, from which it will be clearly seen that there was an extensive lack of fusion. The failure of the welded seam occurred partly between the weld metal and the plate and partly through the weld itself.

Welds that are seriously defective are caused almost invariably by lack of control of the welding procedure or inadequately trained welding operators. It is the intent of most of the codes relating to welding to reveal inherent defects in methods of welding and lack of ability on the part of operators. This statement is particularly true of the A. S. M. E. Code for Unfired Pressure Vessels. However, before the adoption of that code many fusion welded vessels had been built and there was often but little, if any, knowledge on the part of manufacturers of a proper procedure for welding or the ability of the operators. Furthermore, a great number of fusion-welded vessels being built today are not constructed in accordance with the code requirements. All such vessels have given insurance companies great concern because unfortunately no one can determine the soundness of a welded joint by mere visual examination of its exterior surface.

The company which the writer represents has recently investigated a number of questionable fusion-welded vessels by trepanning plugs from the welded seams and etching these plugs to detect lack of fusion or slag inclusions.

The tool used for the purpose is shown in Fig. 3. While similar tools have been on the market for some time, it is only recently that the cylindrical saw has been available in high speed steel and a tool that will withstand severe service is quite necessary for this kind of work.

A problem that was presented in using a tool of this kind was the retention of the plug after it had been severed from the vessel and for this purpose a special split pilot or mandrel was developed as shown in Fig. 4. With such a pilot the plug is retained and withdrawn from the vessel with the hole saw or trepanning tool as shown in Fig. 5. The plug is then sectioned, polished and deep etched in a boiling solution of equal parts of hydrochloric acid and water.

By using the proper size of tool it is a simple matter to close the opening in the vessel by tapping the hole and screwing in a pipe plug.

Some examples of plugs that have been cut from questionable vessels will undoubtedly be of interest. Fig. 6 shows some specimens removed from a fusion-welded ammonia brine cooler which had been in service for several years. It is interesting to compare these plugs with the etched cross section of the weld shown in Fig. 3. What might have happened if the vessel, from which the plugs were cut, had remained in service may readily be conjectured.

Fig. 7 shows some plugs cut from a fusion-welded ammonia generator in an absorption system. After seeing these plugs the owner decided to replace the vessel.

Fig. 8 shows some plugs cut from a fusion-welded soap kettle. Not only were there poor penetration and fusion, but cracking of the weld had also taken place.

A large number of vessels have been examined by this method and in the great majority of cases the welds have been found defective to some extent. In many cases the defects were so extensive that the vessels were considered to be in a really dangerous condition for operation and were either retired from service or satisfactorily repaired.

It may be argued that in cutting plugs from a vessel specimens might be obtained that do not represent the true condition of the welded seam. It has been the practice, however, to cut not one but several plugs from each vessel. Invariably, the same degree of defectiveness or soundness has been revealed in all plugs. It is hardly conceivable that a welded seam could be dangerously defective and not have that condition exist to a degree, at least worthy of consideration, throughout its entire length.

It has also been claimed that the drilling of holes in the welded seam weakens the vessel. However, if the vessel is operating with a reasonable factor of safety no measurable weakness has been introduced if the seam is sound, and if it is not, then the vessel should not be operated at all. With the size of holes that are used for examination of welded seams no one would hesitate to make a pipe connection to the vessel by drilling and

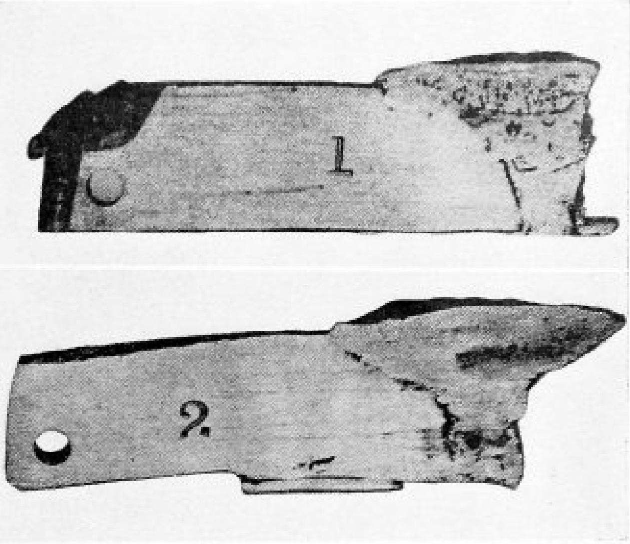


Fig. 2—Etched specimens of seams from vessel shown in Fig. 1

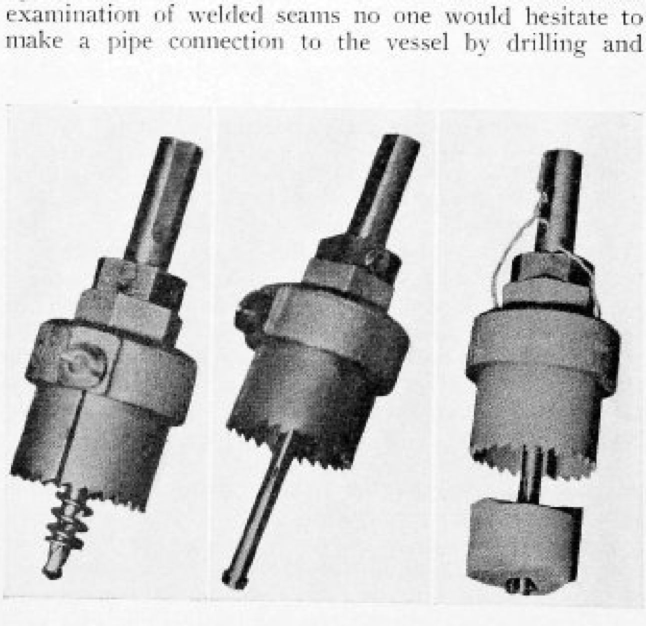


Fig. 3—(Left) Tool used for trepanning plug from welded seam.
Fig. 4—(Center) Special spring and split pilot developed for trepanning tool.
Fig. 5—(Right) How plug is withdrawn

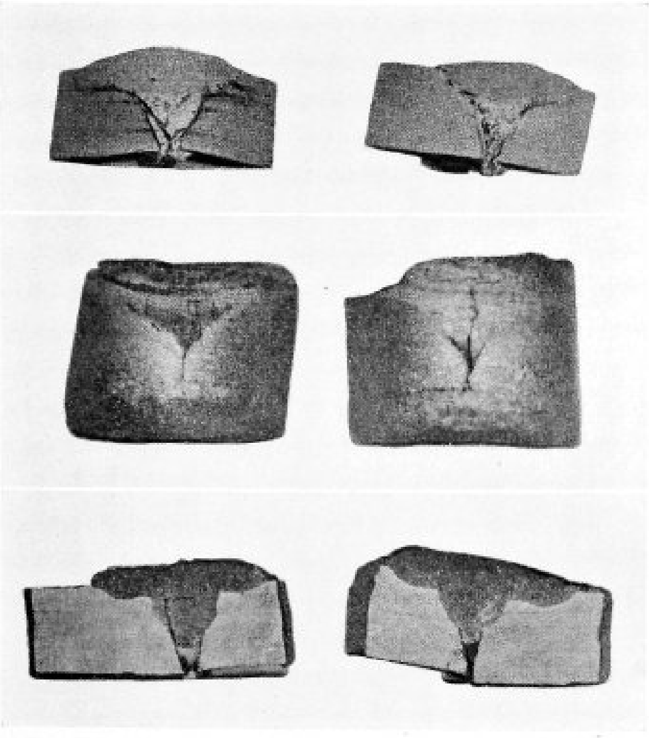


Fig. 6—(Top) Specimens from fusion welded ammonia brine cooler. Fig. 7—(Center) Plugs cut from welded ammonia generator. Fig. 8—(Bottom) Plugs from fusion welded soap kettle

tapping the shell in the solid plate. Why, then, be concerned with such an opening in a sound weld?

Turning now from the "antiques" and "non-code" construction, consideration may be given the methods now employed for the qualification of welding operators. There is today a strong and well justified feeling that the methods in various codes for the qualification of operators are too expensive and it is the writer's belief that such methods have gone too far in one direction and not far enough in another.

The tensile strength and ductility of deposited weld metal is determined entirely by the materials used and the proper control of the process. Those physical properties should be determined through an investigation of the process itself by making and testing welds fabricated with all essential variables under careful control. On the other hand, the reliability of a welded joint, provided proper materials have been used and a proper procedure followed, depends entirely upon the fusion between the weld and base metals. The matter of obtaining that fusion lies wholly in the hands of the welding operator. Therefore, when the welding procedure is properly controlled, it is unnecessary to test welding operators for tensile strength and ductility and, in this respect, qualification tests have gone too far. What should be determined is the operator's ability to follow and apply the given procedure so as to make a sound weld, and for this purpose some simple tests will suffice. Such tests, however, should be extended to an examination of the operator's ability to make sound welds of the type he is to fabricate in actual construction. Usually, simple bending or breaking tests will be adequate.

For the qualification test of a welding operator to be employed in the fabrication of the longitudinal or circumferential seams of welded pressure vessels where the work is all done in the flat position, the making of a weld in the flat position and of the kind to be used in construction, whether of the single or double butt, or lap type, is sufficient.

Operators who are to be employed in construction where position welding is done should be required to make welds of the same type and in the same position as will be encountered in actual construction.

Pipe-line welding operators should make welds between two pieces of pipe, the axis of which may be in either the horizontal or vertical position with the pipe either rolled or fixed in position while the weld is made, depending on the actual working conditions.

It may not follow, however, that a welding operator who has shown ability to make a rolling or fixed position pipe weld can make a sound weld when fabricating a pipe fitting. This fact has been well demonstrated by a number of tests that have recently been made of fusion-welded pipe fittings.

It is now the practice of one very prominent manufacturer of fusion-welded pipe fittings to qualify operators by having them make representative pipe fittings and cutting these apart for etching.

This same method of examination of unusual construction which cannot be tested by other means such as bending or breaking is extremely valuable in developing the proper method of welding of such specimens and in enabling the welder to visualize what he is doing.

The question as to how often a welding operator should be given a qualification test is one that has been debated frequently and at great length. The A. S. M. E. Code for Unfired Pressure Vessels calls for a re-qualification test every six months unless the operator is continuously employed on the same type of work in which case a qualification test once each year is sufficient. On the other hand, it is conceivable that a man might be qualified today and within the next few days develop some organic trouble such as an injury to the eye which would make it impossible for him to make a sound weld, yet that condition would not be detected for six months or possibly a year. Furthermore, when making a weld for qualification purposes the operator is using every care and he may not feel it necessary to observe such care in actual production work. A procedure which constantly checks the operator's ability to make a sound weld is what is really desired. Such a check is obtained, of course, when fusion-welded vessels are X-rayed as required for U-68 vessels and power boiler drums.

While the discarding of the requirement for tension and ductility tests in the qualification of a welding operator together with the adoption of improved methods of checking for soundness would very greatly decrease the expense involved and at the same time give better information than is now being obtained, it would not dispense with the present requirement of most codes that operators must undergo subsequent tests at periodic intervals. Furthermore, such retests, however frequently they are made, are not a constant check.

For U-69 and U-70 vessels the Unfired Pressure Vessel Code requires only that the welding operators be qualified. If, on such vessels, the practice of trepanning plugs from welded seams were adopted as a requirement in shop inspection a constant check would be made at relatively small expense and as long as the welding operator showed an ability to make a sound weld by such a test it would be unnecessary to call for any periodic qualification tests. Such a procedure would be far more positive than the present practice of depending entirely upon qualified operators. If would, of course, be necessary that the operator make a satisfactory test weld before being permitted to engage in actual construction.

If this suggested procedure were adopted, not only would the expense of qualifying welding operators be very greatly reduced but there would be much greater assurance of the soundness of the welded seams.

PRACTICAL PLATE DEVELOPMENT — XII

Breeching Header

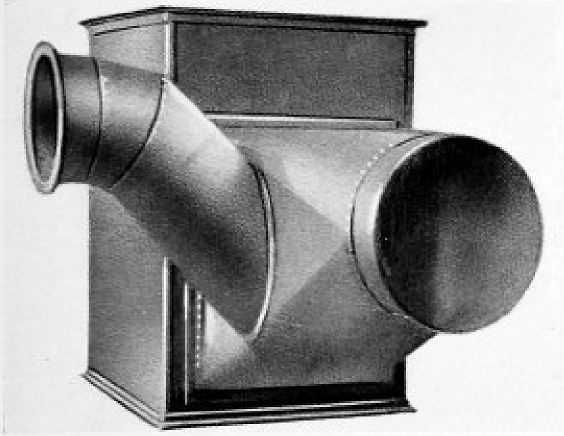


Fig. 104—Breeching header layout problem

By George M. Davies

The breeching header to be considered is illustrated in Fig. 104 and consists of a square duct, with a branch transition piece.

The transition piece is square where it joins the duct and has a circular outlet. A branch pipe elbow joins into the vertical side of the transition piece. The breeching header illustrated in Fig. 104 is shown in Figs. 105, 106 and 107. Fig. 105 is the elevation, Fig. 106 the plan and Fig. 107 the end view. For convenience in illustrating the development, the outline of the breeching header is taken on the neutral axis of the plates.

The first step in laying out the breeching is to obtain the miter line of the elbow connection and the transition piece in the elevation. Draw the profile of the elbow connection as Fig. 108 and divide same into any number of equal parts, the greater the number of equal parts taken the more accurate the final development. Twelve parts are taken in this case and the divisions are numbered from 1 to 12 as shown. Then parallel to the center line *E-F* draw lines through the points 1 to 12, extending same cutting the side of the transition piece *G-H*, Fig. 106; number the points from 1 to 12 as shown.

Next draw the profile of the elbow connection piece in the elevation as shown on Fig. 109, and divide same into the same number of equal parts as was taken in profile, Fig. 108, and number the corresponding points in Fig. 108 as shown.

Then parallel to the center line *L-P* draw lines through the points 1 to 12, extending same into the elevation, Fig. 105, cutting the line *R-S*, locating the points 1 to 12 on *R-S* and cutting the miter line *T-U*, locating the points 1′ to 12′ on *T-U*. Then parallel to the center line *M-N* draw lines through the points 1′ to 12′ cutting the miter line *V-W*, locating the points 1″ to 12″.

Next parallel to the center line *N-O* draw lines through the point 1″ and extend same down into the elevation; then draw a line parallel to the center line *X-Y* through the point 1 in the plan and extend it down into the elevation, cutting the line just drawn parallel to *N-O* through the point 1″, locating the point 1°, Fig. 105. Continue in this manner until the points 2° to 12° are located. Connect the points with a line which will be the miter line between the elbow connection and the transition piece.

Development Section A

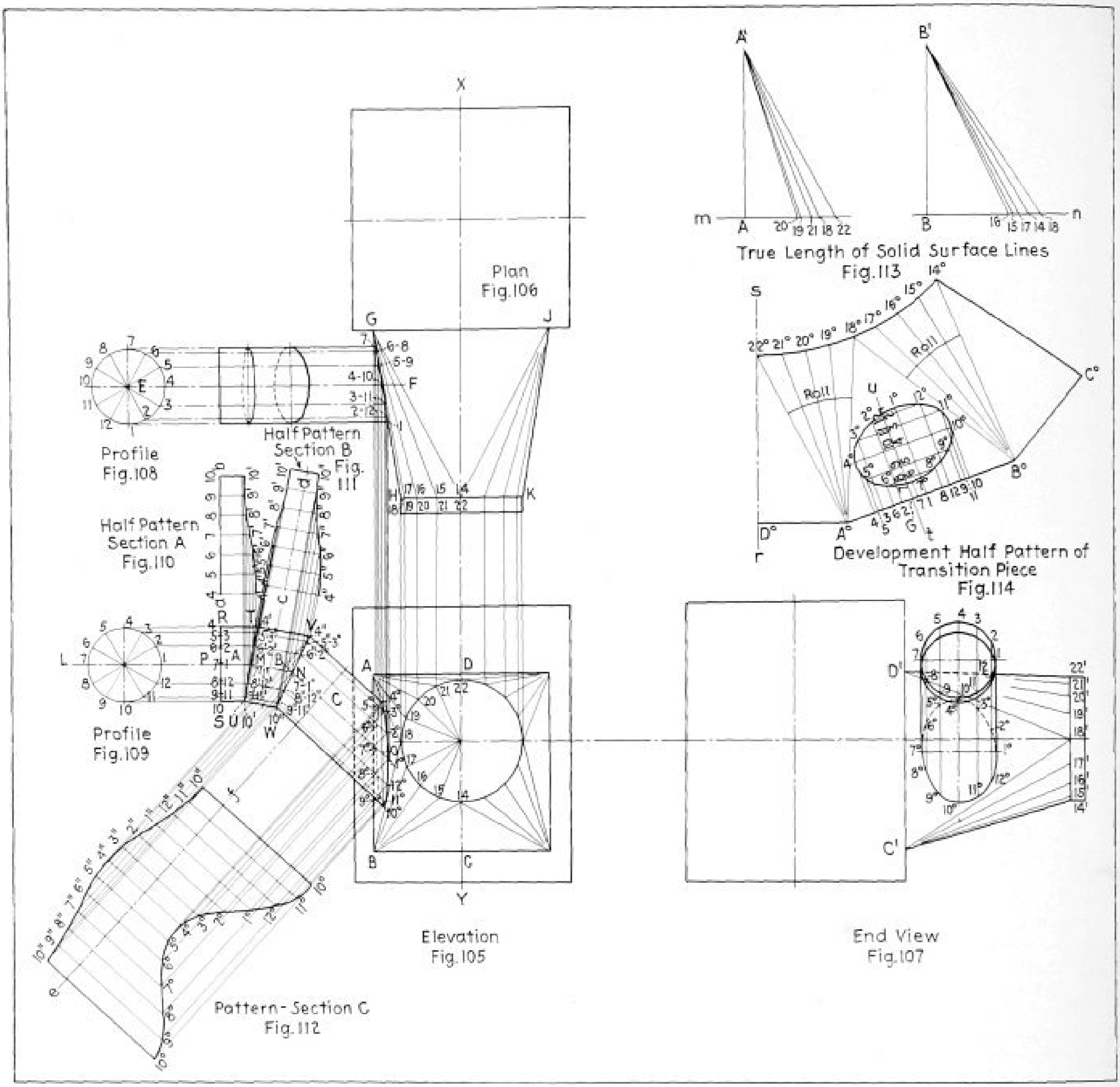
Extend the line *R-S* as *a-b* and from *a* step off six spaces equal to the spaces taken in the profile, Fig. 109. Number the spaces from 4 to 10 as shown; through the points 4 to 10 erect perpendiculars to *a-b*. Then perpendicular to the center line *L-M*, Fig. 105, draw a line through the point 4′, Fig. 105, cutting the perpendicular just drawn through the point 4, Fig. 110, locating the point 4′, Fig. 110. In the same manner locate the points 5′ to 10′, Fig. 110, completing the half pattern of section *A*, a duplicate of this pattern being necessary to complete the whole pattern.

Development Sections B—C

The procedure for developing the patterns of sections *B* and *C* is the same as for section *A*, being sure that lines *c-d* and *e-f* are perpendicular to the center lines of their respective sections and that the spaces are taken from the profile, Fig. 109. Complete the patterns as shown in Figs. 111 and 112.

Development of the Transition Piece

From an inspection of the transition piece, it will be noted that with the exception of the fact that the elbow connection enters on one side only, the transition piece is symmetrical on each side of the center line *X-Y*; and therefore a development of one-half of the transition piece can be duplicated for the other half. Divide one-half of the circular end of the transition piece as shown in the elevation, Fig. 105, into any number of equal parts, eight being taken in this case. Number the points from 14 to 22 as shown. Connect point *B* and the points 14 to 18, and the point *A* and the points 18 to 22 with solid lines. These lines are the surface lines of the transition piece in the elevation. Next parallel to the center line *X-Y*, draw lines through the points 14 to 22 and extend them to cut the line *H-K* in the plan; number these points from 14 to 22. Connect the points 14 to 22



Development of patterns for breeching header

with the point *G*. These lines are the surface lines of the transition piece in the plan.

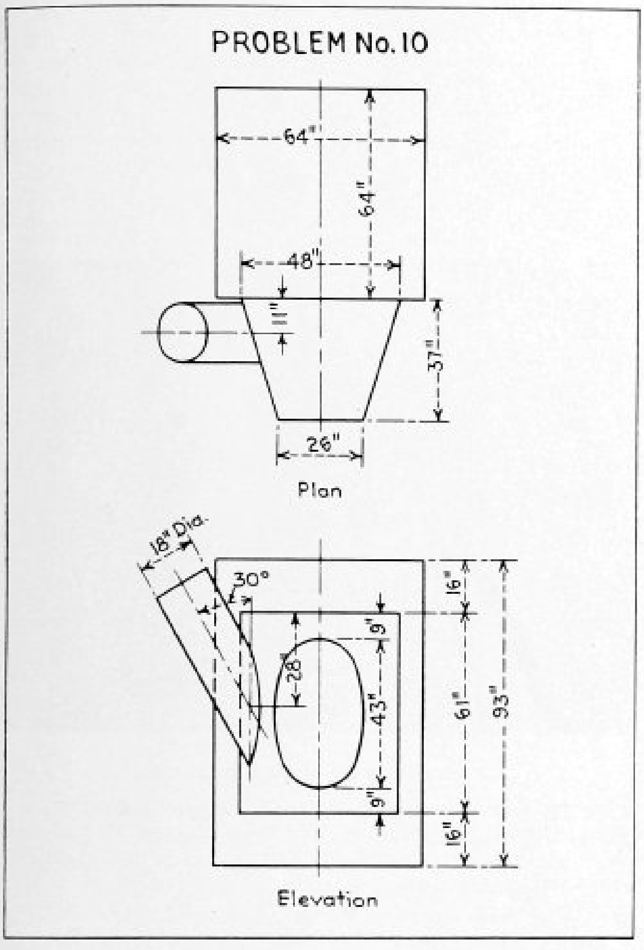
In order to make the pattern, it is first necessary to obtain the true lengths of the surface lines as shown in the elevation and plan views. This is done in Fig. 113. Draw any line as *m-n*, and at *A* erect a perpendicular as *A-A'*, making *A-A'* equal to the perpendicular distance between the lines *H-K* and *I-G* of the plan, Fig. 106. Then from *A* on the line *m-n*, step off the distance *A*-22 equal to distance *A*-22 of the elevation, Fig. 105. Connect the points *A'* and 22, Fig. 113. The distance *A'*-22 is the true length of the surface line *A*-22 of the elevation. Continue in this manner making the distances *A*-21 to *A*-18, Fig. 113, equal to *A*-21 to *A*-18, Fig. 105. The distance *A'*-21 to *A'*-18, Fig. 113, is the true length of the surface line *A*-21 to *A*-18 of the elevation.

In like manner obtain the true lengths of the surface lines *B*-14 to *B*-18 of the elevation, Fig. 105.

DEVELOPMENT OF THE TRANSITION PIECE PATTERN

Draw any line as *r-s* and at any point as *D*° step off the distance *D*°-22° equal to *D'*-22', Fig. 107. Then with *D*° as a center and with the trams set equal to the distance *D-A*, Fig. 105, scribe an arc; then with point 22° as a center and with the trams set equal to the distance *A'*-22°, Fig. 113, scribe an arc cutting the arc just drawn, locating the point *A*°. With the point 22°, Fig. 114, as a center and with the trams set equal to the distance arc 22-21, Fig. 105, scribe an arc; then with *A*°, Fig. 114, as a center and with the trams set equal to *A'*-21, Fig. 113, scribe an arc cutting the arc just drawn, locating the point 21°, Fig. 114. Continue in this manner making the distances 21°-20°, 20°-19°, 19°-18°, Fig. 114, equal to the arcs 21-20, 20-19, 19-18, Fig. 105, and the lengths *A*°-20°, *A*°-19°, *A*°-18°, equal to the distances *A'*-20, *A'*-19, *A'*-18, Fig. 113, completing the pattern to the line *A*°-18°, Fig. 114.

Problem No. 10 for Readers to Lay Out



The correct solution of Problem No. 10 will be published in the June issue

Then with $A°$ as a center and with the trams set equal to A-B, Fig. 105, scribe an arc. With 18° as a center and with the trams set equal to B'-18, Fig. 113, scribe an arc cutting the arc just drawn, locating the point $B°$, Fig. 114. With 18° as a center and with the trams set equal to the arc 18-17, Fig. 105, scribe an arc; then with $B°$ as a center and with the trams set equal to B'-17, Fig. 113, scribe an arc cutting the arc just drawn, locating the point 17°. Continue in this manner making 17°-16°, 16°-15°, 15°-14° equal to 17-16, 16-15 and 15-14, Fig. 105, and $B°$-16°, $B°$-15°, $B°$-14° equal to B'-16, B'-15, B'-14, Fig. 113, completing the pattern to $B°$-14°, Fig. 114.

With $B°$ as a center and with the trams set equal to B-C, Fig. 105, scribe an arc; then with 14° as a center and with the trams set equal to the distance C'-14', Fig. 107, scribe an arc cutting the arc just drawn, locating the point $C°$, Fig. 114, completing the half pattern of the transition piece. On one-half of the pattern the cut-out for the elbow connection piece is located as follows: Draw the line as t-u perpendicular to $A°$-$B°$, and from $A°$-$B°$ step off on the line t-u the distances G-1 to G-12 equal to the distances G-1 to G-12 along the line G-H, Fig. 106. Draw lines parallel to $A°$-$B°$ through the points 1 to 12. Then from $B°$ step off on the line $B°$-$A°$ the distances $B°$-1 to $B°$-12 equal to the vertical distances between the line B-C and the points 1° to 12°, Fig. 105, locating the points 1 to 12 on the line $A°$-$B°$.

Erect a perpendicular to $A°$-$B°$ at the point 1 on $A°$-$B°$, and where it cuts the parallel line drawn G-1 distance away from $A°$-$B°$ locates point 1°, Fig. 114. Erect a perpendicular to $A°$-$B°$ at the point 2 on $A°$-$B°$, and where it cuts the parallel line drawn G-2 distance away from $A°$-$B°$ locates point 2°, Fig. 114. Continue in this manner locating the points 3° to 12°, Fig. 114. Connect these points with a line completing the cut-out for the elbow connection. Seams should be added to the patterns wherever required.

(To be continued)

Accidents to Power Boilers*

Five men were injured on July 29, 1935, when a locomotive firebox type boiler at an Illinois saw mill exploded, supposedly because the safety valve was corroded in its seat. When the rising pressure could not be relieved by normal means, it blew out the lower sheet of the barrel. The force thus released virtually demolished the mill. One man was thrown against a shed, the blast tearing off his overalls and one shoe. He sustained severe head injuries. His roll of bills ($124) was unrolled and scattered over a wide area. Another man was hurled through a window and landed in a sawdust pile. He received internal injuries. Two men were scalded, one of them seriously, and the fifth man, a bookkeeper who was standing at some distance from the boiler, was plastered with mud and light debris. He escaped with minor burns.

* * *

Low water and lack of attention were blamed for the explosion of a track locomotive at the scene of Western logging operations on August 5, 1935. The engineman and fireman were thrown from the cab and sustained minor injuries. When the crown sheet pulled loose from the staybolts, the force of the explosion caused the engine to fall over on its side, and hot fire brick and coals were scattered over the adjacent area. The locomotive was backing up a considerable grade at the time of the accident, a fact which would have made a condition of low water additionally hazardous because the crown sheet would be uncovered more quickly than on a level track.

A locomotive firebox type boiler at a Southwestern oil test well exploded because of low water and overheating on September 27, 1935. The fireman sustained painful burns, and the boiler was blown from its foundation. Because of the accident, drilling operations were suspended until another boiler could be installed.

* * *

In Boiler Maker and Plate Fabricator for June, 1935, there was an article on "The Repair of Bulged Shell Plates and Drums" in which was mentioned several accidents caused by overheating of shell plate as the result of accumulations of scale and sediment. Such an accident occurred because of scale accumulation in a 60-inch diameter horizontal tubular boiler at a Southern lumber mill on October 5, 1935. The bagged area was on the rear course near the blow-off flange and extended approximately 50 inches girthwise of the boiler and 40 inches lengthwise. The most serious bulge was 8 inches in depth and there were two ruptures, one 3 inches long

* From records of the Hartford Steam Boiler Inspection and Insurance Company.

and another $3\frac{1}{2}$ inches long, at the bottom of the bag. The bulging had caused the rear tube sheet to pull forward about 2 inches and the lower rows of tubes to distort. According to the plant manager, the first warning of the trouble was the fireman's report that he could not keep water in the boiler. The inside of the plate carried a heavy coating of adhering scale. In addition to this, however, there undoubtedly was a large accumulation of loose scale which fell off when the section was removed.

* * *

How a high and low water alarm may be unexpectedly rendered useless is shown by the recent official inquiry into the explosion of a bent tube type boiler at a London, England, sugar manufacturing plant. The boiler was fitted with a high and low water alarm of the balanced-float type. The boiler always showed a tendency to prime when worked hard, and apparently there was difficulty at times in maintaining a proper water level. On August 10, 1934, while the boiler was under steam, a tube suddenly ruptured, and subsequent examination showed that other tubes were swollen, hogged or sagged. The front drum had sagged $\frac{5}{16}$ inch, and a large number of tube holes were distorted. The only conclusion possible was that there had been serious overheating through lack of water. The feed arrangements and the gage glasses were found in a satisfactory condition, but through frothing or priming, deposits had collected on the high-water float to such an extent that it required 3 pounds 6 ounces on the low-water float to effect a balance when the boiler was empty. Under these circumstances, the low-water float was unable to fall with the water level, and for all practical purposes the alarm was inoperative. The damage to the boiler was considerable, but fortunately no very serious personal injuries occurred to members of the staff. "Low-water alarms of good construction," said the engineer surveyor-in-chief, "are appliances of proved utility, but, as shown in this case, they may actually be a source of danger if relied on to the exclusion of indications given by the water gages, regarding the correctness of which there should be no uncertainty while the boiler is allowed to continue under steam." He might also have added that all automatic appliances must be frequently examined and maintained in proper operating condition.

* * *

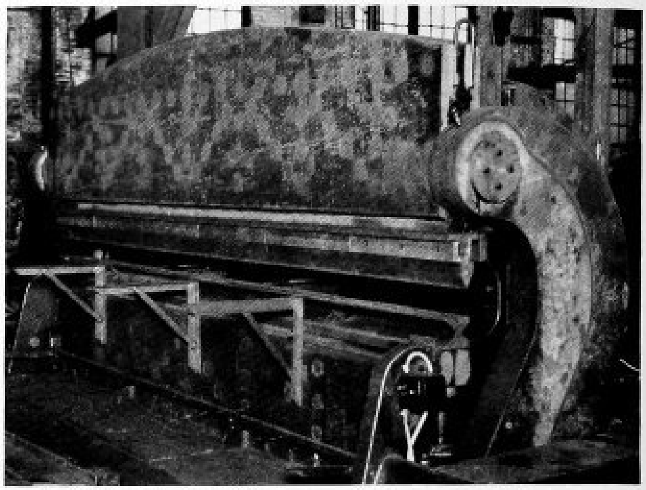
A small vertical tubular boiler, 18 inches in diameter and 30 inches in length used to drive an oil pump for a large boiler at a Southern milk plant, caused extensive property damage on October 27, 1935, when it exploded. After passing through the engine house and over several residences, the shell, which had torn free from the top head and flue sheet, landed a block and a half from the plant. The core shot like a bullet into a neighboring house, which was severely damaged. Windows in several residences were broken by flying debris or by the explosion itself. While the cause of the accident was not definitely determined, it was learned that the explosion occurred soon after the auxiliary boiler had been lighted preparatory to starting the main boiler.

Giant Arc-Welded Press Brake Completed

A 500-ton capacity steel press brake, said to be one of the largest of its type ever manufactured, and capable of bending materials 16 feet long, is announced by the Boom Boiler and Welding Company, Cleveland.

Revolutionary in design, the Boom brake pulls two leaves together instead of merely pushing one leaf down. This eliminates approximately 30 percent in material and permits easy adjustment for bending by raising or lowering the bottom leaf which is moved by worm drive controlled by a switch mounted on the front of the machine. Different, also, from conventional practice all driving mechanism, adjustment shafts, etc., are below floor level, leaving the entire top clear and eliminating danger resulting from possible overhead breakage.

The new brake is 24 feet 2 inches in extreme length, 16 feet 1 inch long between housings, 7 feet 1 inch wide, 9 feet 11 inches extreme height and 6 feet 9 inches high above the floor. The weight is 61 tons. The two leaves of the brake are 17 feet 7 inches long, 4 feet high, 10 inches thick and weigh 8 tons. Links are 8 feet 3 inches long overall, 8 inches thick and 3 feet 4 inches wide from drive center to the link's outside. Bending members are of high carbon steel, machined to meet bending requirements. Housings, both inner and outer, are 6 feet 8 inches long. The inner is 8 feet 11 inches high, outer 3 feet.



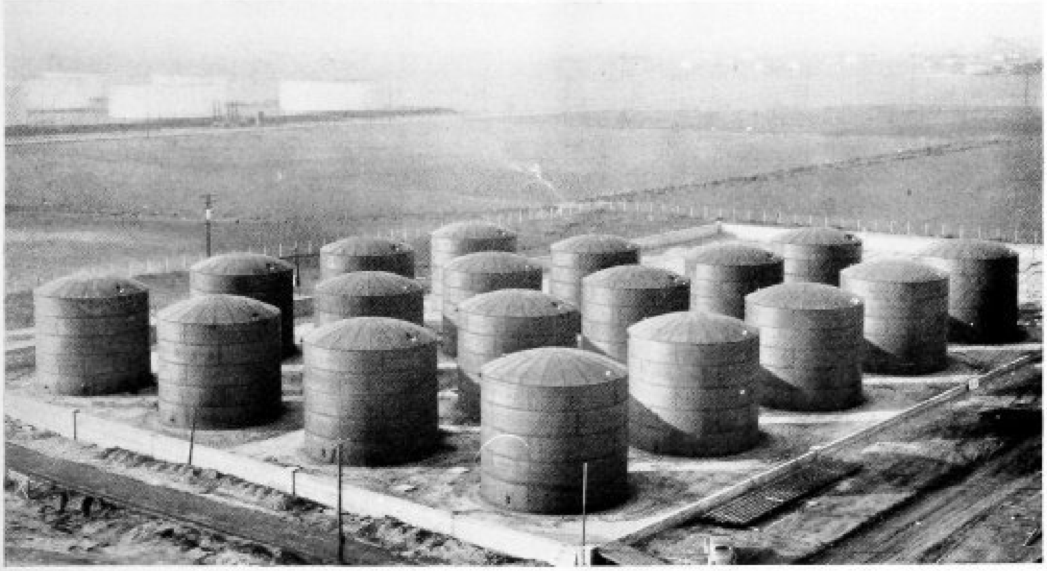
Steel press brake of 50 tons capacity

Construction is entirely of steel, arc-welded. Not a single casting is used. Providing maximum rigidity per minimum pound of weight, arc-welded steel construction permitted 30 days' saving in time and $2200 in cost through elimination of patterns and pattern drawings. Machining costs were said to be $1500 less than would be the case with castings.

According to the manufacturer, the building of a machine so large would not be practical with cast-iron construction. To obtain equal rigidity in ribs and flanges with cast iron, weight would be increased by more than 100 percent. All welding was done by the shielded-arc process with equipment supplied by The Lincoln Electric Company, Cleveland.

Power for operating the brake is furnished by a 30-horsepower electric motor in conjunction with a 2-ton fly-wheel and is transmitted by V-belts to gears and shafting. Operation is two-speed—4 or 20 strokes per minute.

WELDING EQUIPMENT.—Under the title "Weld It Well," the Harnischfeger Corporation, Milwaukee, Wis., has published a 24-page Bulletin covering the complete line of P & H-Hansen arc welders from 50 to 800-amperes units as well as welding fixtures and accessories. Condensed specifications and performance data are included.



Eighteen 5000-barrel welded tanks completed in one month's time

Arc Welding Speeds Tank Erection

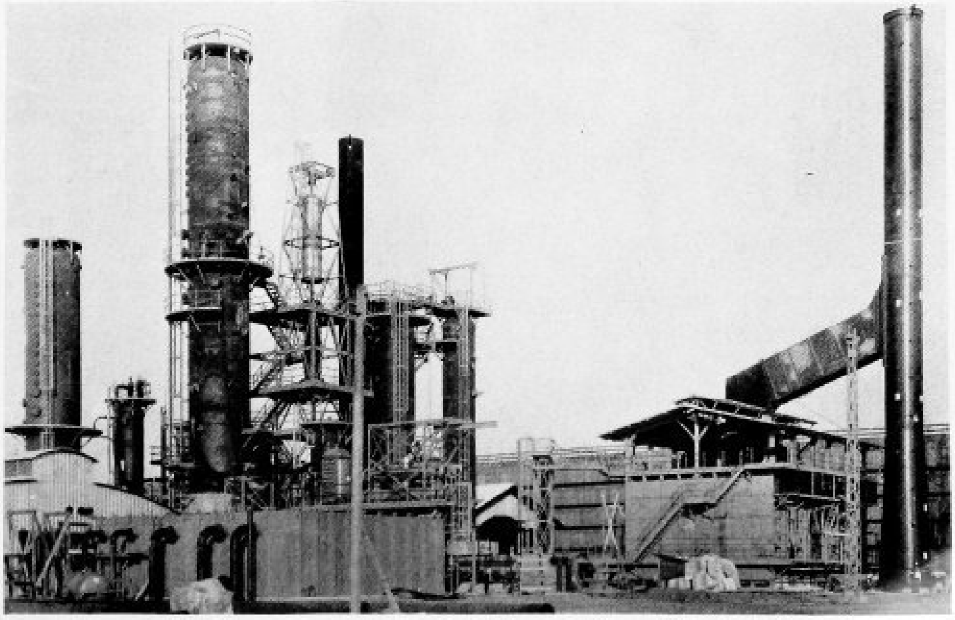
Unusually fast construction of storage tanks was noted recently when eighteen 5000-barrel units were built complete in one month at Santa Fe Springs, Cal. The tanks were built by The National Tank and Manufacturing Company, Los Angeles, for the Wilshire Oil Company at its new Santa Fe Springs refinery.

The tanks are identical in size and construction and are 30 feet high and 35 feet in diameter. Thickness of plate is 1/4 inch in bottoms and bottom rings, 3/16 inch in sides and covers.

Fast erection was made possible by simplified arc-welded construction. The tanks are simply pieces of steel plate cut and formed, then welded together into an integral unit without use of intermediate connecting members. Approximately 3000 feet of welding was required in each tank. All welds were plain butt type and all welding was done by the shielded arc process with electrodes and equipment supplied by The Lincoln Electric Company, Cleveland, O.

In addition to permitting fast erection, the use of arc welding greatly simplified fabrication of the steel. Elimination of connecting members reduced detailing and entirely eliminated punching and drilling.

The tanks were engineered and constructed by The



Arc welding extensively used for the construction of refinery stacks on equipment on the West Coast

National Tank and Manufacturing Company, with the welding engineering assistance of C. O. Conzett, Los Angeles office, The Lincoln Electric Company.

Arc welding is also being used in construction of the refinery equipment. The pressure equipment, built by The Southwestern Engineering Company, Los Angeles, is arc-welded. Two 125-foot stacks—one erected by The Buehler Tank Company, the other by Western Pipe & Steel Company—are one-piece all-welded construction. Piping and miscellaneous structural steel work is being erected by the general contractor, the Ralph M. Parsons Company, Norwalk, O., using Lincoln shielded-arc equipment.

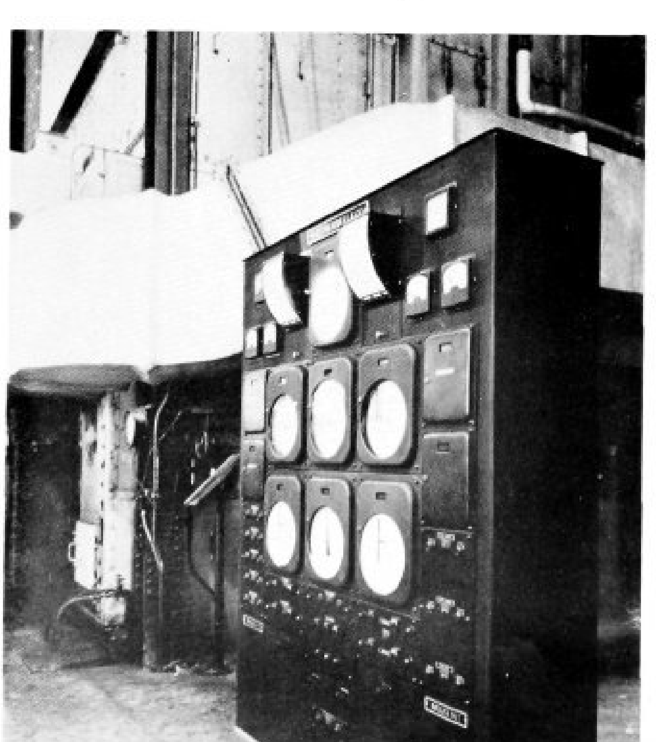
New Boiler Installed at Ottumwa Plant

After more than four months' work, the huge new boiler of the John Morrell and Company, Ottumwa plant has been completed and placed in operation according to an announcement by Barney Winger, master mechanic of the company.

Built at the cost of approximately $150,000, the new boiler will produce 450,000,000 pounds of steam annually and is the latest development in coal-burning steam plants.

It was necessary to build the boiler 45 feet high in order to secure the most efficient combustion of the pulverized coal while in suspension. Coal is conveyed directly from the cars to bunkers suspended from the roof. Two pulverizers, with 120-horsepower electric motors, crush the coal into the consistency of flour before it is fed into the boiler chamber.

Draft fans mix the coal and air and feed the fuel into the combustion chamber at a constant speed. Superheaters raise the steam temperature 100 degrees for distribution throughout the plant. The combustion chamber is 21 feet wide and 22 feet deep. It burns 120 tons of coal per day and generates a pressure of 200 pounds per square inch, although capable of 450 pounds.



Control panel of new steam plant built by Combustion Engineering

The unit was built and installed by the Combustion Engineering Company, New York. Pulverizers and waste traps were manufactured by the Riley Stoker Corporation, Worcester, Mass., and Prat-Daniel Corporation, New York, respectively.

Activities of the St. Louis Welding Society

This year the St. Louis Welding Society is celebrating its fifth anniversary. The original constitution and by-laws were accepted at a general meeting of its members on the evening of January 23, 1931. At the start there were only six sustaining or firm members and about twenty-five individual members. Today there are 73 sustaining members and 30 individual members.

A sustaining membership entitles all men in the employ of a member company to attend meetings, without the necessity of taking out an individual membership. This accounts for the comparatively small number of the latter. No salaries are paid to any of the officers.

The purpose of the society is to "strive to perfect and advance the art of welding, or any future developments pertaining to this or allied arts. To create a spirit of mutual respect, esteem and co-operation between participants of all phases of welding and allied arts. To strive for the professional improvement of designers, engineers, supervisors, operators, and others engaged in or affiliated with the art of welding. To assemble and propagate knowledge of the advancement of the art for the benefit of the membership. To act as a representative of the membership in the formation and defining of codes and regulations pertaining to welding and allied arts. To advocate and provide qualification tests for operators."

Among the means to be employed for the attainment of the above objects are periodical meetings for the reading of professional papers, and the discussion of subjects pertaining to the art; the formation of committees to co-operate with similar organizations or code committees for mutual exchange of data pertaining to welding.

The following restrictions are emphasized in the constitution:

"The society will not interfere with any employer-employe's relation and will not participate in or advocate any employer-employe's relationship plan or arrangement."

"It is the intent that the society shall not be used as a commercial or advertising medium."

Since its inception, many welding authorities have addressed the membership of the society.

Plant inspections have also been a feature of particular interest to the members, and among those visited have been the Midwest Piping & Supply Company and the St. Louis Public Service Company.

The society's evening meetings are generally held once a month in the Auditorium of the Gallaudet School, 1604 South Grand Boulevard, St. Louis, which seats approximately 250 persons, and on several occasions there has been "standing room only." The average attendance is about 150.

The officers and members of the board of directors are R. C. Thumser, president; A. W. Harris, vice-president; F. J. Feldhaus, treasurer, and Lockwood Hill, executive secretary. The executive board meets on the first Friday of each month, at which time comprehensive plans are made for the promotion and progress of welding in the St. Louis metropolitan district.

Bureau of Locomotive Inspection Issues Amendments to Rules

On March 2, an announcement was issued by John M. Hall, chief inspector of the Bureau of Locomotive Inspection, Interstate Commerce Commission, that certain amendments had been made to the rules and instructions for inspecting and testing locomotives other than steam. The publication containing the laws, rules and instructions for inspecting and testing locomotives of this class will later be reprinted to include the changes covered in the order issued by the commission. Many of the amendments apply to heating boilers and so are essential information for the boiler department. The order of the Interstate Commerce Commission transmitting the amendments is as follows:

IN THE MATTER OF RULES AND INSTRUCTIONS FOR THE INSPECTION AND TESTING OF LOCOMOTIVES PROPELLED BY OTHER THAN STEAM POWER IN ACCORDANCE WITH THE ACT OF FEBRUARY 17, 1911, AMENDED MARCH 4, 1915, JUNE 26, 1918, AND JUNE 7, 1924

Present. Frank McManamy, commissioner, to whom the above-entitled matter has been assigned for action thereon.

Rules and instructions for inspection and testing of locomotives other than steam being under further consideration;

And it appearing, That upon application of the Mechanical Committee representing the Association of American Railroads certain proposed new and amended rules for the inspection and testing of locomotives propelled by other than steam power should be established pursuant to section 5 of the Boiler Inspection Act, as amended;

And it further appearing, That at a conference held on February 26, 1936, in the office of the Chief Inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission, at Washington, D. C., representatives of the carriers and representatives of the employees appeared and were heard, full consideration was given to all suggestions offered by interested parties and necessary changes or modifications of certain rules to promote the safety of employees and travelers on railroads were unanimously agreed upon:

It is ordered, That, effective May 1, 1936, rules Nos. 205 (b), 213 (b), 223 (a), 229 (c), 252, 256 (a) (b), 302 (d), 303 (b), 308, 309 (a), 315 (a) (b) (c) (d), 316 (a) (b), 317 (a) (f), 320 (a), and 323 (c) shall be, and they are hereby modified to read as follows:

205. (b) A suitable governor shall be provided that will stop and start the air compressor within 5 pounds above or below the pressures fixed.

213. (b) The date applied, the original diameter of the journal, and the kind of material, shall be legibly stamped on each driving axle and truck axle applied after January 1, 1926.

223. (a) Truck center plates shall fit properly, and the male center plate shall extend into the female center plate not less than three-fourths inch, except on motor trucks constructed to transmit tractive effort through center plate or center pin the male center plate shall extend into the female center plate not less than 1½ inches and the center plates shall be securely fastened and maintained.

229. (c) Front cab doors or windows located in line of enginemen's vision when looking ahead from their usual and proper positions in the cab shall be equipped with an appliance that will clean the outside of the window over sufficient space to provide a clear view of track and signals ahead; or with a window hinged at the top, placed in the glass of each of the aforesaid doors or windows, that can be easily opened, closed, and fastened in desired position, and properly fitted so as to prevent an undue amount of rain or snow being blown into the cab. Hinged windows shall be 5 inches high, and the lower edge shall be without obstruction and as nearly as possible in line of the enginemen's vision when seated in the cab.

252. Voltmeters and ammeters on units receiving power from an outside source shall be tested whenever any irregularity is reported, but not less frequently than once every six months. Voltmeters and ammeters on units driven from power generated within the unit shall be tested whenever any irregularity is reported, but not less frequently than once every twelve months. Meters reading more than 5 percent in error shall be corrected.

256. (a) Fuel reservoirs shall be arranged so they can be filled and vented only from outside of the cab or other compartments. Vent pipes shall not discharge on the roof nor on or between the rails.

(b) A gauge which will properly indicate the level of fuel in fuel reservoirs shall be provided for each reservoir, or series of reservoirs that are connected together and filled from a common source, and so located as to be readily visible to the person filling the reservoir or reservoirs.

302. (d) The maximum allowable working pressure on cast iron boilers shall not exceed 15 pounds per square inch.

303. (b) A metal badge plate showing the name and boiler number and safe working pressure shall be attached to each boiler. The badge plate on each steam boiler shall be provided with a line indicating the lowest permissible water level and shall be attached to the boiler adjacent to the water glass. The badge plate on each hot water boiler shall be attached to the boiler adjacent to the firing opening. If boiler is lagged, the lagging and jacket shall be cut away so that plate can be seen.

308. The exterior of every boiler shall be thoroughly inspected before it is put into service, and whenever the jacket and lagging, or casing, are removed. The jacket and lagging shall be removed at least once every five years from internally fired boilers, and from pressure parts of other boilers, and a thorough inspection made of the entire exterior of the boiler while under

hydrostatic pressure. The jacket and lagging shall also be removed whenever on account of indication of leaks the United States inspector or the railroad company's inspector considers it desirable or necessary.

309. (a) Every boiler before being put into service, and at least once every 12 months thereafter, shall be subjected to a hydrostatic pressure 25 percent above the working pressure. While this test is being made by the railroad company's inspector, an authorized representative of the company, thoroughly familiar with boiler construction, must personally witness the test and thoroughly examine the boiler while under hydrostatic pressure. Before hydrostatic test is applied, the safety valves or water relief valves shall be removed and the holes capped or plugged, or means provided for holding valves closed without compressing the springs.

315. (a) Each boiler shall have a gauge which will correctly indicate the working pressure. Pressure gauge shall be graduated to not less than one and one-half times the allowed working pressure of the boiler. Gauges must be located so that they will be kept reasonably cool and can be conveniently read.

(b) Pressure gauges shall be tested at time of quarterly boiler inspection, and whenever any irregularity is reported.

(c) Pressure gauges shall be compared with an accurate dead-weight tester or test gauge, constructed for the purpose of testing gauges. Other than at times of application of hydrostatic tests pressure gauges used on hot water boilers may be tested in conjunction with the test of water relief valves by comparison, under air pressure, with an accurate test gauge. Gauges found inaccurate shall be corrected before being put into use.

(d) Every pressure gauge used on steam boilers shall have a siphon of ample capacity to prevent steam from entering the gauge. The pipe connection shall enter the boiler direct and shall be maintained steam tight between boiler and gauge. The siphon pipe must be removed and it and its connections examined to see that they are open, each time the gauge is tested. Pressure gauges used on hot water boilers may be mounted on the expansion tank provided no valves are interposed between the expansion tank and boiler.

316. (a) Every steam boiler shall be equipped with at least two safety valves and every hot water boiler shall be equipped with at least one water relief valve, the capacity of which shall be sufficient to prevent, under any conditions of service, an accumulation of pressure of more than 5 pounds above the allowed working pressure. The safety valves shall be connected with the boiler independent of any other connection, and located as closely to the boiler as may be consistent without discharging inside of cab. Water relief valves may be mounted on the expansion tank of hot water boilers provided no valves are interposed between the expansion tank and the boiler. Sufficient clearance to prevent damage shall be provided where safety or relief valves or connections pass through cab structure.

(b) Safety valves on steam boilers shall be set and tested under steam at time of quarterly boiler inspection, and also when any irregularity is reported. When setting safety valves, the water in the boiler shall not be above the highest gauge cock. When safety valves or water relief valves are set or tested two gauges shall be used, one of which shall be so located that it will be in full view of the person setting such valves. Other than at times of application of hydrostatic test water relief valves on hot water boilers may be tested with air pressure; at times of hydrostatic test they shall be tested with hydraulic pressure. Gauges shall in all cases be tested immediately before the safety valves or water relief valves are set or tested or any change made in the setting, except that gauges on hot water boilers may be tested with air pressure simultaneously with the test of relief valves at times other than when the hydrostatic test is made. If the indicated pressure of the test gauge and the gauge on boiler vary more than 3 pounds, they shall be removed from the boiler, tested, and corrected before the safety valves or water relief valves are set.

317. (a) Every steam boiler shall be equipped with at least one water glass, and three gauge cocks which can be easily opened and closed by hand. The lowest gauge cock and the lowest reading of the water glass and the line on the badge plate shall correspond and be not less than 2 inches above the danger line. The danger line shall be that at which there will be no danger of overheating any part of the boiler. The danger line for vertical firetube boilers shall be not less than one-half the length of the tube above the lower tube sheet; and for vertical submerged tube boilers, the upper surface of the top tube sheet. Steam boilers which are not now equipped with water glasses shall have them applied before July 1, 1926.

(f) Water glasses and pressure gauges shall be sufficiently illuminated to enable accurate readings to be easily made.

320. (a) Boilers shall be washed as often as water conditions require. Steam boilers in service shall be washed not less frequently than once each month, and at the time of quarterly inspection. Hot water boilers in service shall be washed not less frequently than once each year. When boilers are washed, all handhole plates and washout plugs shall be removed. If boilers can be washed without removing handhole plates and washout plugs, such plates and plugs shall be removed immediately after boiler is washed and as thorough interior inspection be made as conditions will permit. Sediment and scale shall be removed from water tubes at washout periods.

323. (c) Fuel reservoirs shall be arranged so they can be filled and vented only from outside of the cab or other compartments. Vent pipes shall not discharge on the roof nor on or between the rails.

Shop Problems of Streamlining Locomotives

(Continued from page 79)

shop. While comparatively light sheets are used for the cowlings, the work involves extremely complicated layout and the utmost care in shaping the plates. The streamlined surface must be completely free of irregularities and all surfaces must be fair. The front end view of the Pennsylvania locomotive which appears on page 80 gives an excellent idea of the task of shaping the cowling.

But few shops have the equipment necessary for this class of work, so this must be taken into account when streamlining is to be undertaken. Dies, rolls and bending equipment of many types must be employed. The most serious difficulty as evidenced by the experience of shops which have undertaken work of this character is lack of experience of the shop staff in developing and fabricating the oddly shaped plates required.

The era of streamlining is of course not coming with any rush in the railroad field, but it may be well for the mechanical department, and the boiler shop in particular to consider the problems involved when modernization of equipment starts in earnest.

Expansion Joint Prevents Air Leakage in Smokebox

To overcome the difficulty of keeping an air tight joint at the point where the pipe carrying steam to the cylinders passes through the shell plate of the smokebox of a locomotive boiler, John T. Kelly of the M. K. & T. at Tulsa, Okla., before his demise some months ago had invented and patented an expansion joint, which was successfully demonstrated on locomotives of that railroad.

Because of the fact that this joint may offer a solution to a troublesome operating problem, some details of its construction will be given.

As shown in Fig. 1, the casing which is welded to the shell of the boiler, is made up of two wrought-iron tubes connected by an annular trough-shaped ring of copper, brazed to the tubes top and bottom as in Fig. 2. The lower end of the casing is in the form of an annular ring which makes an airtight fit around the steam pipe. This joint may be readily calked to maintain it in a tight condition.

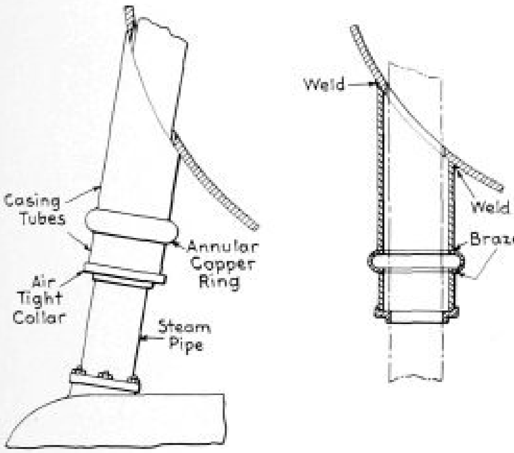


Fig. 1—Details of expansion joint

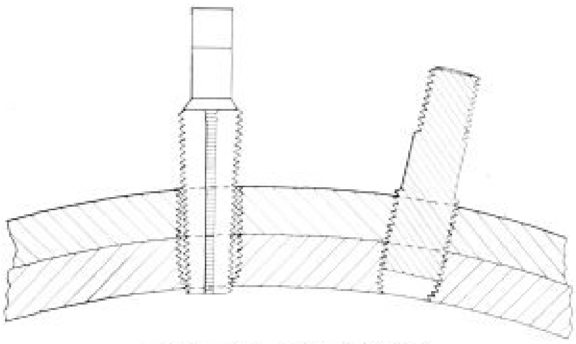
Owing to the provision of the expansion ring of copper, the casing adjusts itself to any movement of the steam pipe, maintaining its airtight condition at all times.

Communications in connection with the use of this expansion joint should be addressed to Mrs. John T. Kelly, 2419 E. 14th Street, Tulsa, Okla.

What Causes Boiler Studs to Leak?

Leaky boiler studs are an expensive proposition, especially those that appear tight during hydrostatic test, but leak after the locomotive is in service. Epidemics of leaky studs are likely to occur after a change in the gang, for men of long experience seldom have trouble with leaks. One shop had an epidemic of leaky boiler studs and undertook to find out the cause. Investigation showed that studs screwed in newly drilled holes seldom leaked, and that the trouble occurred when old stud holes were re-tapped and new studs fitted. Further investigation showed that the threads in these holes were imperfect, even though bright and shiny and enough metal removed by tapping to increase the size of the hole $\frac{1}{16}$ inch. The stud holes were cross-threaded in tapping. This condition was indirectly brought about by the original studs not extending clear through the reinforced sheet.

In scaling the boiler the metal around the stud holes was battered over somewhat as shown in the sketch. Later when these holes were re-tapped for the renewal of studs the tap started to cut a thread in the small end of the hole before it was perfectly alined with the old threads; this condition being referred to as cross-threaded, the term used in a slightly different sense than when a nut is cross-threaded or started crooked on a bolt. The threads looked all right on casual examination, but closer inspection showed them to be a little rough, and they were found by trial to be leaky no matter how tightly screwed in place or how thoroughly doped with graphite. To get a perfect thread in these cross-threaded holes it was found necessary to tap them out $\frac{3}{32}$ inch larger than the original diameter.



Showing why boiler studs leak

Experienced workmen can tell when a boiler tap starts correctly in a tapped hole by the "feel" of it, and when it does not start right withdraw it and try again. If the thread is perfect, a stud will not leak if drawn into place with a 14-inch pipe wrench. A poor thread will leak even though the stud is screwed in tightly enough to twist the metal.

Clinics Demonstrate Welding Methods

A series of welding clinics to demonstrate the best methods for welding various non-ferrous metals and clad materials are being held in four West Coast cities during April. Included are practical problems involving the latest methods of both electric and oxy-acetylene welding and brazing on Monel metal, aluminum, nickel, copper, brass, bronze, Inconel, and Nickel-Clad steel.

The clinics are being conducted by welding engineers of The International Nickel Company, The Aluminum Company of America and The Revere Copper and Brass Company. They were held April 3 and 4 at the Wilkinson Company, Limited, 190 West Second Avenue, Vancouver, B. C., April 10 and 11 at Eagle Metals Company, 21 Spokane Street, Seattle, Wash.; April 17 and 18 at the Pacific Metals Company, Limited, 3100 Nineteenth Street, San Francisco, Cal.; and April 24 and 25 at the Pacific Metals Company, Limited, 1400 South Alameda Street, Los Angeles, Cal.

Nickel Alloy Lecture Given at Newark

The history and usefulness of nickel as an alloying element were outlined in a lecture sponsored by the New Jersey Chapter of the American Society for Metals at Newark College of Engineering, March 20, by Mr. N. B. Pilling, Manager of the Bayonne Laboratory of The International Nickel Company, Inc., New York.

Mr. Pilling stated that only within the past 50 years had advancing metallurgical technique made nickel one of the most widely used metals. After discussing the early use of the metal, the speaker cited six alloys in which nickel plays an important part as the alloying element. Pure nickel, for instance, has proved itself indispensable for radio tubes. Monel Metal, containing about two-thirds nickel and one-third copper, is useful for applications in which resistance to corrosion by acid or other corrosives is an important consideration. Cupro-nickel alloys have been widely used for certain marine applications due to their excellent resistance to corrosion by salt water.

Nickel silvers, which he stated were among the earliest alloys discovered, are used widely in modern architecture due to their solid white metal structure and the possibility of developing pleasing shades by varying the nickel and copper contents. In conclusion, Mr. Pilling discussed the increasing use of the nickel brasses and bronzes because of the improved mechanical properties of the alloyed brass and bronze.

New Books

THE METAL CLEANING HANDBOOK. By Robert W. Mitchell, Ph. D. Size, 6 by 9¼ inches. Pages, 215. Illustrations, 287. Garwood, N. J., 1936: Magnus Chemical Company. Price, $1.00.

This book was prepared to explain and describe briefly the general principles of modern metal cleaning. The equipment used in this activity and modern practices are discussed with the aid of numerous charts and illustrations. The problems of cleaning from the chemical standpoint are reviewed and general recommendations for various types and degrees of cleaning offered.

METALLURGICAL DIALOGUE. By Albert Sauveur, Sc. D. Size 5½ by 8 inches. Pages, 166. Illustrations, 11. Cleveland, 1935: American Society for Metals.

To find that elusive but vital quality, readability, incorporated in a book on an abstract science is an experience that is always a rare delight. To discover also that one of the foremost authorities on the development of metal science and Gordon McKay Professor of Metallurgy at Harvard is the author of the work is a double pleasure. Dr. Sauveur has presented an imaginary interview between the dean of American metallurgists and a typical Harvard undergraduate, which involves discussion on such intriguing topics as Hysteresis, Ferrite, Alloy Steels, Manganese, Creep, Corrosion, etc., in such an interesting fashion that the reader is as enthralled as by a fine detective story.

Trade Publications

NICKEL CAST IRON.—The publication "Nickel Cast Iron News," published in the interest of producers and users of cast iron by the International Nickel Company, Inc., New York, in its March issue illustrates and discusses the wide use of nickel cast iron, from small household appliances through automotive equipment to heavy machinery and equipment.

CHROMIUM STEEL.—The outstanding properties of 18-8 chromium steels are reviewed to point out the need for improved fabrication in a booklet recently published by the Linde Air Products Company, New York. An illustrated discussion of improvements in technique and materials, together with description of actual welding procedure, is included in the bulletin.

BOILER TUBES.—The Babcock & Wilcox Tube Company announces the publication of a new sixteen-page fully illustrated booklet presenting, as the title implies, "Seven Facts About Boiler Tubes." This booklet explains the effect of the manufacturing process upon the quality of a boiler tube, and answers many other important questions of interest to every buyer or user of boiler tubes.

GENERATING PLANTS.—The Kohler Company, Kohler, Wis., manufacturers of portable and small stationary electric generating plants, has recently brought out a booklet on its product. This booklet shows the adaptability of the Kohler plant to construction, marine, home and emergency purposes. Full description is given of the various models and recommendations for most suitable application.

ELECTRIC WELDING.—The Quasi-Arc Company, Ltd., Grosvenor Gardens, London, has just published the first number of Electric Welding to appear in 1936. In this issue, reference is made to electric welding practice in many countries using Quasi-Arc electrodes, electric welding reinforcement of steel structures and to the facilities provided by the company for instruction in electric arc welding.

NICKEL STEELS AND ALLOYS.—The International Nickel Company, Inc., New York, has published recently two bulletins. The first, "Nickelsworth," contains discussion and description of various uses made of nickel alloys, particularly Monel. The second gives a rather complete discussion on the properties of nickel steel, stainless and nickel alloy steels under low temperature conditions and a description of several applications using these metals under the above conditions.

TEMPERATURE CONTROL.—The Bristol Company, Waterbury, Conn., manufacturers of various forms of industrial instruments, has brought out recently a bulletin covering the subject of automatic temperature controllers and recorders. These instruments, operating on the thermocouple principle, are represented as a simple but highly accurate power and industrial plant temperature control aid, the operation of which serves to reduce spoilage, rejected and poor quality material, fuel wastage, processing time, etc.

INSULATING FIREBRICK.—Complete information on the five types of Babcock & Wilcox Insulating Firebrick is contained in a new booklet recently released by The Babcock & Wilcox Company, New York. A table of physical characteristics, curves of thermal conductivity, a list of applications, a typical example of savings in time and fuel costs effected through the use of these insulating firebrick, and illustrated descriptions of the special, light-weight constructions developed by The Babcock & Wilcox Company should interest those concerned with furnace construction and maintenance.

NON-RETURN VALVES.—Discussions of the selection of the correct size of non-return valves, design details, choice of materials and other valve considerations are among the subjects contained in the new catalogue, recently issued by The Edward Valve and Manufacturing Company, Inc., East Chicago, Ind. A full line of valves for all standard temperatures and pressures and constructed of all kinds of materials is illustrated, described and tabulated. Included in this line is a series of forged steel stop-check valves with both screw and flange ends. A brief discussion on welded ends is also given.

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

VOLUME XXXVI NUMBER 4

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Request for change of address should reach us on or before the 15th of the month preceding the issue with which it is to go into effect. It is difficult and often impossible, to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address, please be sure to send us your old address as well as the new one.

BOILER MAKER AND PLATE FABRICATOR is a member of the Associated Business Papers, Inc. (A. B. P.), and the Audit Bureau of Circulation, (A. B. C.)

EDITORIAL STAFF: H. H. Brown, Editor. L. S. Blodgett, Managing Editor. H. W. MacDonald, Associate Editor.
BUSINESS MANAGER: Warner Lumbard.

Contents

VENTILATING FANS.—The Propellair, Inc., Springfield, O., manufacturers of all types of ventilating fans, has recently brought out a circular illustrating a new development in Propellair circulator fans. This is the type of fan that can be operated at two speeds and is distinguished by the amount of air flow it supplies and its thrifty use of current. Special construction has so reduced the air hum that it can be used in all rooms where a minimum of noise is desirable.

Communication

The Vanishing Apprentice

TO THE EDITOR:

I note on page 69 of the March, 1936, issue of BOILER MAKER AND PLATE FABRICATOR the lament of E. C. Williams of the lack of apprentices in the art of boiler making and the consequent scarcity of boiler makers which may result in the future. I could not let the matter go by just from a superficial reading of the same but felt that I must type a brief to Mr. Williams, letting him know that I fully agree with him, and wished that things could be changed, but since the condition has been of long standing, I doubt very much if any attempt will be made to revise the code. True he can call the attention of the "powers that be" to the fact and urge that more young men and boys be taken in to learn a branch of industry that I know from the tone of his article, that he must be very much interested in, but I am very much of the opinion that there the matter will rest. The trouble that he complains of has been going on for years and, as he states, the zero points of supply and demand have been reached, with the accent on demand and the supply written with a minus sign.

The writer went all through the problem many years ago, and I may suggest a partial list of the answers and say in all truth that the answers were not correct. When we were complaining of the scarcity of the old-fashioned hand riveter, men that knew the art and whose work was written in tightness and neatness that was a pleasure to look upon, along comes the pneumatic riveter or gun. Well, we spent time, money and patience breaking in men to drive rivets with the gun. The old hand riveter would not use it, as he was "agin" it; consequently the novice learning to use it lacked the experience necessary to do other things than just "plug a rivet in the hole" to get good work. Eventually we got men that did very well but were troubled more or less with weeping rivets; then comes along the "baby calker" to run around the rivet with a calking tool to insure tightness.

I knew of one manufacturer that used to write into the specification of boilers, "every rivet calked before boiler leaves shop." This was not the practice with hand riveting. Then came a scarcity of flange-turners and fitters, so along comes the acetylene torch and this filled the gap in a kind of a way, so we go merrily on.

But why worry, Brother Boiler Maker? The work will go along, not as you or I would do it, but as the other "feller" does it. One doesn't have to eat spinach to live, but "Oh, Boy," how it has been hammered into the rising generation as the essential thing.

Some time back the writer had this experience: The "big shot" said to me, "We'll have to get some boiler makers." I asked him where? "I'll advertise for them," he replied. I told him he would not be able to get them that way, and the only way would be to train them ourselves. He advertised, got a goodly number of replies; then the elimination took place, and when I gave him a list to draw from it was so small that he dropped the matter. This is the attitude, advertise to get the very thing you should make yourself or, in other words, "rob the other feller."

On the other hand, what inducements are there for a young man to learn boiler making? The remunerations after serving long, hard years at the trade are nothing to boast of. True, he may become a foreman, but think how few of the boiler makers you have known have ever become foremen. Dear boiler maker, don't worry about the future of boiler making, that will adjust itself.

Incidentally, I enjoyed reading "The Boiler Maker's Lament" in the same issue. It must have been written by one who knows—one who has sounded all the depths and shoals of boiler making, mostly depths. I am wondering if he ever got the home he started to save for in verse three. Well, it's consoling to know that another member of the craft can see the humor in boiler making, for most of it is hard plugging. Come agin, poet.

Wollaston, Mass. WILLIAM K. CAMPBELL.

Questions and Answers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Freezing of Hydraulic Riveters

Q.—Will you kindly let us know what other shops do during severe cold weather to keep their hydraulic riveter from freezing? We have had trouble with the operating valve freezing.—H. H. L.

A.—Manufacturers of hydraulic riveters advise that in order to prevent freezing, the entire hydraulic system, including pipes and valves, should be drained when not in operation. Another way of preventing freezing is to add a certain amount of glycerine to the water. There is also on the market a pneumatic riveter head mechanism which can be mounted on the hydraulic riveter frame and eliminates the freezing possibility entirely.

Blue Print and Layout Books

Q.—Would you kindly let me know where and what book or books I could buy that would help me in reading blue prints and laying out work in a job shop? Our work is mostly on tanks and containers of all sizes and shapes. The material we use is mostly mild steel from 12 gage to 1 inch in thickness on riveted and welded jobs. I have catalogues from two or three book companies but they don't seem to have any books that fit definite enough in this work.—D. H. B.

A.—There are but few up to date books upon the subject of reading blue prints and laying out. Perhaps the most helpful book you could obtain upon the subject of laying out would be "Laying Out for Boiler Makers," published by the Simmons-Boardman Publishing Company, New York City. Recent books on the subject of blue print reading are as follows:

"How to Understand the Reading of Blue Print Drawings," the fundamental principles simply explained by Edward R. Vigneau, published by David McKay Company, Philadelphia, Pa. "Blue Print Reading and Shop Sketch for the Metal Trades," by H. C. Givens, published by John Wiley & Sons, Inc., New York City.

Applying Staybolts to Locomotive Boilers

Q.—I would appreciate it very much if you could give me information about the most practicable and safe way to rivet staybolts from 15/16 inch to 1⅛ inches diameter, with pneumatic tools, in locomotive boilers, giving details of the tools that are used, with sketches. V. E. B.

A.—The following methods of applying staybolts in locomotive boilers are in use in various locomotive shops and are considered practical and safe.

Cutting of Bolts.—All staybolts should project through the sheet not less than 3/16 inch or more than 1/4 inch for driving. The preferable method of cutting off the staybolts is with a cutting torch whenever it is available. In shops where boilers are removed from frames and can be turned in any position, then nippers can be used to good advantage. Nippers, however, do not make a good, even end to drive, and it is often necessary to go over the bolts and trim them with a chisel before driving. The use of a chisel in cutting off stay ends can hardly be considered, as it will damage the thread on the bolt and in the sheet; it also elongates the holes, and for this reason the cutting torch should be used whenever possible. The cutting torch cuts the bolts to a uniform length and can be readily used with the boiler in any position.

Fig. 1—Pneumatic hammer for driving staybolts

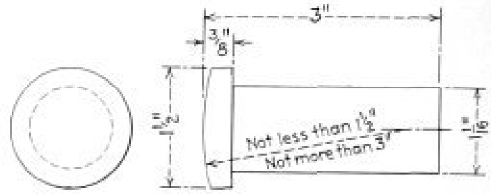


Fig. 2—Typical staybolt die

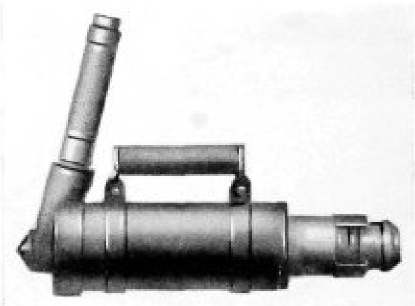


Fig. 3—Pneumatic type holder-on

Driving Staybolts.—Staybolts should be driven with a No. 60 or 6-inch-stroke pneumatic air hammer as illustrated in Fig. 1, using a 1½-inch diameter die. The convex face of the die should have a radius not less

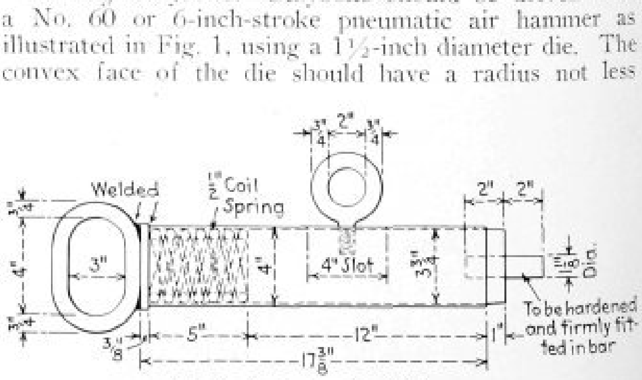


Fig. 4—Spring bar for holding on

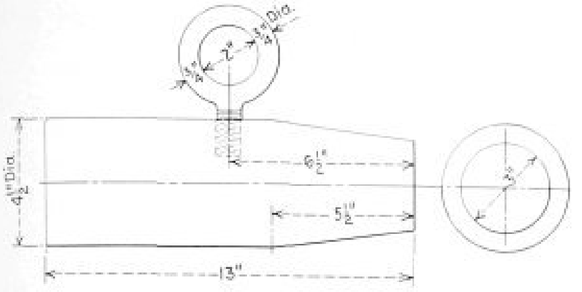
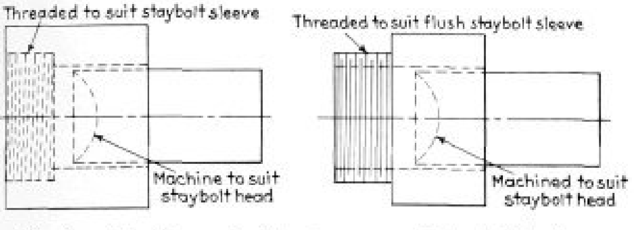


Fig. 5—Dolly bar for holding on purposes



Figs. 6 and 7—Dies used with waterspace, radial and flush sleeves

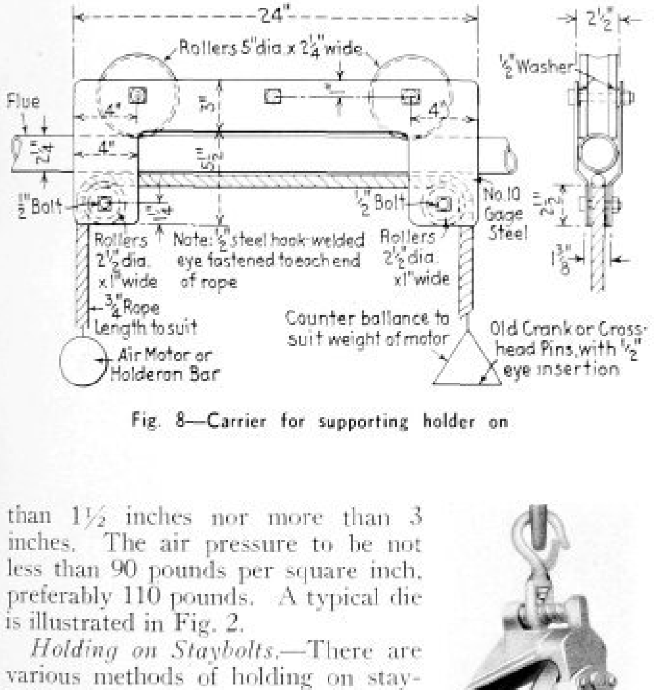


Fig. 8—Carrier for supporting holder on

than 1½ inches nor more than 3 inches. The air pressure to be not less than 90 pounds per square inch, preferably 110 pounds. A typical die is illustrated in Fig. 2.

Holding on Staybolts.—There are various methods of holding on staybolts, the most common being the pneumatic holder-on as illustrated in Fig. 3; the spring bar as illustrated in Fig. 4, and the dolly bar in Fig. 5. The spring bar shown in Fig. 4 is used either for rigid or flexible staybolts, the plunger being reversible by removing the eyebolt and turning the plunger around. The teet, which extends from a machined hole in the end of the bar, is inserted inside of the spring; the eyebolt is replaced and the bar is ready for rigid staybolts. For flexible staybolts the 1⅛-inch teet is machined to fit the bolt head. An ordinary old flexible cap is cut out and welded in a piece of 1¼-inch diameter pipe to guide the teet squarely onto the head of the bolt while driving. Three or more of these riveting sleeves are used at the same time.

Fig. 9—Typical balancer

When holding a flexible bolt, two men are to be employed—one for holding on the bolts, the other to change riveting sleeves and otherwise assist the man holding on. The weight of the plunger is about 40 pounds and is made from a 3½-inch to 3¾-inch old piston, a ½-inch coil spring being used to back up the plunger. The body of the bar is made from an old 4-inch flue with ⅜-inch plate and handle welded on. In using the dolly bar shown in Fig. 5, the same procedure is followed as for the spring bar, except that the die for fitting the heads of the flexible bolts is separate from the dolly bar. Dies used with water-space, radial and flush sleeves are illustrated in Figs. 6 and 7.

Fig. No. 8 illustrates a carrier used for supporting the holder-on or dolly bar so as to relieve the weight for the operator. This carrier is made up in the shop and takes the place of chain falls, balancers and other tools. Such a carrier can be made up and put on a 2-inch or 2¼-inch flue of desired length, belled out with the ends of the flue so the carrier will not come off. Counterweights to suit the various sizes and weights of holder-on and dolly bars may be used. These carriers together with flue, rope, hooks and counterweights can be kept in a convenient place on a rack in the shop. Counterweights may be made up from small scrap, crank or crosshead pins with a ⅜-inch or ½-inch ring inserted to hook on for safety.

If it is desirable, balancers can be purchased, a typical one being illustrated in Fig. 9. These balancers can be set for any load up to 200 pounds and are supported on a flue similar to Fig. 8, using a roller and U-bolt.

Factor of Safety of Boilers

Q.—What is meant by factor of safety, as applied to boilers?

A.—The factor of safety as applied to boilers, or used in any engineering structure subject to stress, is a ratio applied to the known or estimated strength of the material so that there will be a proper margin of strength to guard against failure in operation. The steel plates of a boiler have a known ultimate tensile strength of, say, 48,000 pounds per square inch. If a factor of safety of six is allowed in the design, the allowed stress as estimated by calculation would be 8000 pounds. This would assume that a stress of 8000 pounds per square inch would not be exceeded. However, such an assumption is in error because, due to uneven distribution of the stress, it may easily be possible to have double this stress in certain places.

In actual practice a factor of safety of five or six for boilers has been found suitable. Allowances have to be made for a certain amount of corrosion and wearing away, also for a lack of uniformity of the material and the possibility that full designed thickness of metal may not actually be present everywhere. When all these things are considered it is quite possible that at times some part of a boiler may be subjected to about 12,000 pounds stress. If the elastic limit of the metal is 24,000 pounds, the actual factor of safety is only 2. And since in actual practice failures sometimes occur on this basis of design such factors are none too large for general use. Where a certain part is subjected to very uniform and thoroughly known conditions of stress, and where the behavior of the material is thoroughly understood, a smaller factor of safety may be employed.

Because the factor of safety makes allowances for uncertainties and things that are not fully known, it is sometimes jokingly called the "factor of ignorance." The more thoroughly the behavior of the material, the actual conditions of stress and the operating conditions are known, the more can the factor of safety be reduced.

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Assistant Chief Inspector—J. A. Shirley, Washington.
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States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

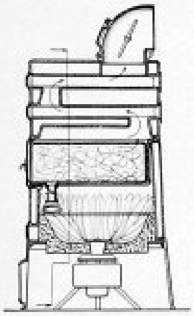
Cities

Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

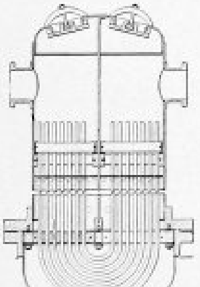
Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,906,023. INCINERATOR APPLIANCE FOR HEATING UNITS. KENNETH J. TOBIN, OF CHICAGO, ILLINOIS.
Claim.—The combination with the combustion chamber of an installed heating unit provided with a heat emitting source, a door opening in said



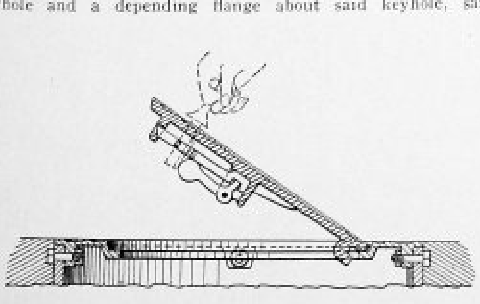
chamber and a door for closing said opening, of a receptacle mounted in said chamber above said heat source, said receptacle having an open front end lying in said door opening, said door serving to close said end, whereby a substantially closed receptacle is provided, said receptacle and said heat emitting source constituting an incinerator. Eight claims.

1,869,967. DESUPERHEATER. SVEND M. JORGENSEN, OF ELIZABETH, NEW JERSEY, ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y.
Claim.—In a desuperheater, the combination of two vertically extending chambers therein, one having an inlet and the other an outlet, U-tubes



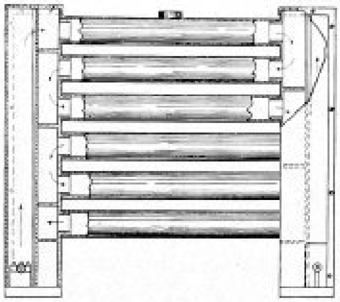
having their mouths facing upwardly for conducting heating fluid from one chamber to the other, and liquid in said chambers in heat absorbing contact with said tubes below their mouths and of the same character in each. Eleven claims.

1,902,731. LOCKING COVER. WARREN S. SHERMAN, OF OKLAHOMA CITY, OKLAHOMA.
Claim.—In a cover lock, the combination of a cover having an elongated keyhole and a depending flange about said keyhole, said flange



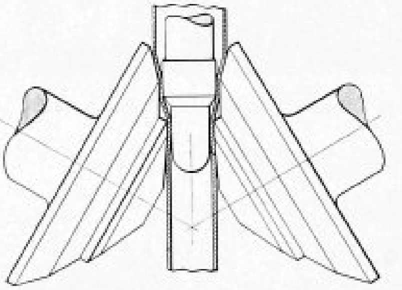
having an outer face substantially perpendicular to the cover throughout the length of said flange, and a locking bolt carried by said cover, said locking bolt including a portion engageable with a key for retracting said bolt, whereby said flange provides a substantially perpendicular stop for the bit of a key to prevent unintentional removal of said key, the bit of said key being provided with a recess allowing insertion, operation and partial retraction of the key so as to receive said flange in said recess and thus stop said key from removal by abutment of its bit against said substantially perpendicular flange. Two claims.

1,905,550. HEATING APPARATUS. WILLIAM A. BOLLINGER, OF PITTSBURGH, PENNSYLVANIA.
Claim.—In a heating apparatus, an end casing, partition walls mounted in said end casing and dividing the latter into a combustion chamber and



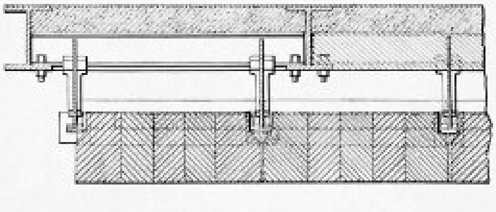
a draft chamber, and a radiator manifold providing a continuous passage having its inlet communicably joined with the upper end of said combustion chamber, the outlet of said radiator manifold being communicably joined with the lower end of said draft chamber. Eight claims.

1,906,286. TUBE EXPANDING MILL. RALPH C. STIEFEL, OF ELLWOOD CITY, PENNSYLVANIA.
Claim.—A tube expanding mill, comprising a pair of skew rolls for engaging the outer surface and an interposed mandrel for engaging the inner surface of the wall of a tube, said rolls and mandrel being provided



with working faces forming a plurality of successive tube-expanding passes of successively increasing diameters and each of constant draft regardless of normal variations in the longitudinal position of the mandrel with relation to the rolls, said rolls between their successive tube-engaging surfaces being offset outwardly beyond engagement of a portion of a tube moving from one to another of said passes. Three claims.

1,968,615. FURNACE WALL. OSCAR NYGAARD, OF SAUGUS, MASSACHUSETTS.
Claim.—In a furnace wall, the combination of a structural steel frame at the back of the wall, said frame including horizontal supporting members, a plurality of brackets mounted on said members and held in a substantially upright plane, each of said brackets including an elongated upright member at the forward part thereof and an arm projecting rearwardly from an intermediate point in the length of said member and re-



leasably mounted on one of the supporting members in said steel frame, bars fastened to the lower portions of and connecting the members of each pair of adjacent brackets, said bars serving to hold said brackets spaced apart but permitting a slight relative movement of said brackets toward and from each other, additional bars located one above the other between each pair of adjacent brackets, said additional bars being supported on and connecting said brackets, and refractory blocks in the front section of said wall engaging said bars and held by the bars in alinement with each other at the fire side of said wall. Seventeen claims.

GET TOGETHER DEPARTMENT
POSITIONS OPEN POSITIONS WANTED

POSITION WANTED

Classified Advertisements—Help and Situation Wanted advertisements appearing in the "Get Together Department," 10c a word an insertion. Minimum charge $2.00 for each insertion. For Sale Advertisements $10.00 a column inch. Any number of inches may be used. Copy must be in this office by the 10th of each month preceding to insure insertion in the issue.

Boiler Maker and Plate Fabricator

Boiler Manufacturers' Annual Meeting

A. C. Baker, secretary of the American Boiler Manufacturers' Association and Affiliated Industries, announces that the annual meeting of the association will be held at Skytop Lodge, Skytop, Pa., on June 1 to 3. Although the plans of the association's meeting are only tentatively prepared as yet, it is important that all member companies make plans to send representatives to the gathering as the present meeting on the eve of a further industrial revival should be of real interest and value to the industries in the coming year.

Expanding Markets

Fusion welding has added tremendously to the scope of activities in the boiler and plate fabricating shops and made it possible for them to fabricate a constantly increasing variety of products. Those concerns that have recognized the possibilities for business in this direction have been the first to benefit from the expanding markets in plate fabricating. In the use of one class of materials only, no less than eighty applications are listed, all of which represent possible business for the boiler or plate fabricating shops. This is a condition that has been created by modern industrial developments; it brings new business and expanding markets to an old industry.

Machine Tool Builders Do an Outstanding Job

The American trade association executives' award for the outstanding achievement by a trade association during the past three years was won by the National Machine Tool Builders' Association because in the midst of the business depression the leaders in this industry set out courageously by their own efforts to restore activity in the machine tool industry to the high level attained before the depression.

This industry faced the difficult task of rebuilding a sales volume which in 1933 had fallen to one-seventh of the 1929 total. The leaders in this association did not wait for more favorable conditions. By two years of united effort they sought to recreate a demand for up-to-date plant facilities, and capped the climax with a machine tool show in Cleveland last fall that was the largest single-industry exposition ever held in the United States.

It was an achievement that proved a powerful agency for business recovery. It showed that defeatism has no place in American industry, and set a high standard of accomplishment that can be followed to advantage by boiler manufacturers and plate fabricators.

Locomotive Building Industry Gains

A survey of production in the railroad locomotive building industry for the first third of 1936 reveals very encouraging progress as compared with last year. During the first four months of 1936 more locomotives were ordered than in the entire year of 1935. Up to the first of May 88 locomotives, of which 69 are steam driven, were ordered this year as compared with 83 of all types and 28 steam ordered in the whole year of 1935. In addition, orders have been placed for five steam locomotives for foreign roads, and inquiries are out for 13 more steam units.

Fabricated Steel Plate Orders Increase

Orders for fabricated steel plate placed in March, as compiled by the Department of Commerce, Bureau of the Census, were slightly greater than for the previous month. The March orders amounted to 29,787 tons, as compared with 27,830 tons for February and 16,832 tons for March, 1935. A breakdown of the results shows that declines occurred in oil storage tank orders, with a decrease of 2320 tons from the previous month, and refining equipment and material orders, which fell off 1145 tons. Substantial increases in gas holders, tank cars and blast furnaces, however, tended to offset these declines, although miscellaneous plate orders contributed most to the increase as the report shows an increase from 18,691 tons ordered in February to 23,690 in March.

On the whole, the reports for the first quarter of the year reveal that the plate fabrication industry is in a substantially better position than it was during the same period a year ago. In the first three months of 1935, 50,674 tons of plate were ordered, while in the same period this year the new orders totaled 96,326 tons. Improvement has been registered in all forms of plate fabrication and the average increase, with the exception of tank cars and blast furnaces, ranges around 100 percent.

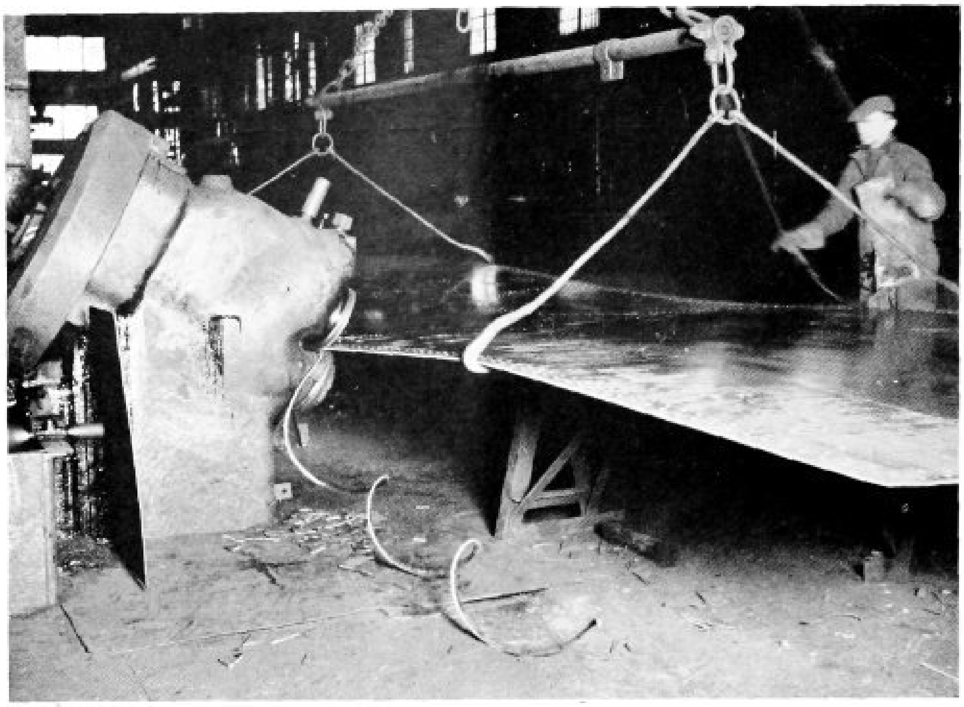


Fig. 1.—Bevel shearing nickel-clad tank car plates

Fabricating Nickel-Clad Steel Plate

By F. P. Huston* and T. T. Watson†

Nickel-clad steel plate is steel plate protected on one side with a dense, homogeneous sheet of pure nickel. The nickel cladding possesses the same chemical and physical properties as hot rolled or hot forged nickel in other forms. It is firmly and permanently bonded to the steel base plate and will not separate from it as a result of temperature change, pressure, vacuum, or deformation in forming.

The availability of large and thick plates makes possible the construction of massive pressure vessels, evaporators, storage tanks, railroad tank cars, and many other types of equipment lined with pure nickel and free from the many disadvantages of thin loose linings which are apt to collapse when operated under vacuum.

The bond between the two metals gives the clad plate heat conductivity the equal of solid steel or solid nickel plate, and maximum thermal efficiency is obtained in all equipment requiring heat transfer through the wall. The thermal coefficients of expansion of nickel and steel are nearly identical and temperature changes within the range where nickel and steel may be used will not affect the bond.

The choice of nickel-clad steel plate to meet particular corrosive conditions is governed by the expected behavior of pure nickel.

Clad Plate Made Tank Cars Possible

Nickel-lined tank cars were desired by the rayon industry for transporting iron-free and copper-free liquid caustic soda. No means were available for lining the tanks with loose sheets to stand the severe conditions of railway service, and the cost of a solid nickel plate tank was considered prohibitive. The adaptability of nickel-clad steel plate was evident, and early in 1929 successful methods of production were developed, and the first car was completed and put in service in October, 1930. Then followed expansion in the use of nickel-clad steel plate and its adoption for numerous types of equipment and kinds of service.

* Development and Research Department, The International Nickel Company, Inc.
† Development and Service Metallurgist, Lukens Steel Company.

The composite plate, clad one side only, is obtainable with various thicknesses of nickel. Standards of 5, 10, 15, and 20 percent of the total thickness have been established—for example, the thickness of the nickel cladding on a ½-inch plate clad 10 percent is 0.05 inch. The 5 percent cladding is furnished, if desired, on plate ½-inch thick and heavier.

The conditions of corrosion, erosion, and abrasion will determine the selection of a thickness of cladding suitable for a particular service.

The limits and sizes of sheared plates are given in Table 1 on page 110.

Nickel-clad steel plate is furnished with a matte finish, nearly white in color, on the pure nickel surface. This finish, however, should not be confused with the luster of cold-rolled and full-finished nickel.

The steel of the composite plate is so selected that the ultimate strength of the clad plate will show a minimum strength of 55,000 pounds per square inch. The nickel being of higher strength than the steel will increase the strength of the composite plate over that of a steel plate of the same thickness, and this increase will be greater for the lighter gages due to their lower-finishing temperatures. This variation will range from 500 pounds per square inch to 5000 pounds per square inch as shown by the following tests made on plates of 4-ply rolling and are on the "as rolled" condition:

Gage	Yield point, pounds per square inch	Ultimate tensile strength, pounds per square inch	Percent elongation in 8 inches	Percent reduction of area
(A) 5/16 inch	36,800	64,900	27.0	56.7
(B) ¼ inch	43,500	63,300	27.0	53.2
¼ inch	39,500	62,100	25.0	57.7
(C) 5/16 inch	38,000	66,400	25.0	59.9
5/16 inch	40,500	63,200	27.0	60.6
⅜ inch	39,800	62,500	30.0	61.7
⅜ inch	37,000	63,600	29.0	60.6
⅜ inch	37,200	62,000	30.5	59.1

The following tests were annealed at 1650 degrees F.—10 percent cladding.

Gage		Yield point, pounds per square inch	Ultimate tensile strength, pounds per square inch	Percent elongation in 8 inches	Percent reduction of area
5/16 inch	(Test from same plate as A above)	37,600	62,800	30.0	61.5
¼ inch	(Test from same plate as B above)	37,300	64,000	31.0	65.0
5/16 inch	(Test from same plate as C above)	38,800	65,300	27.0	60.3

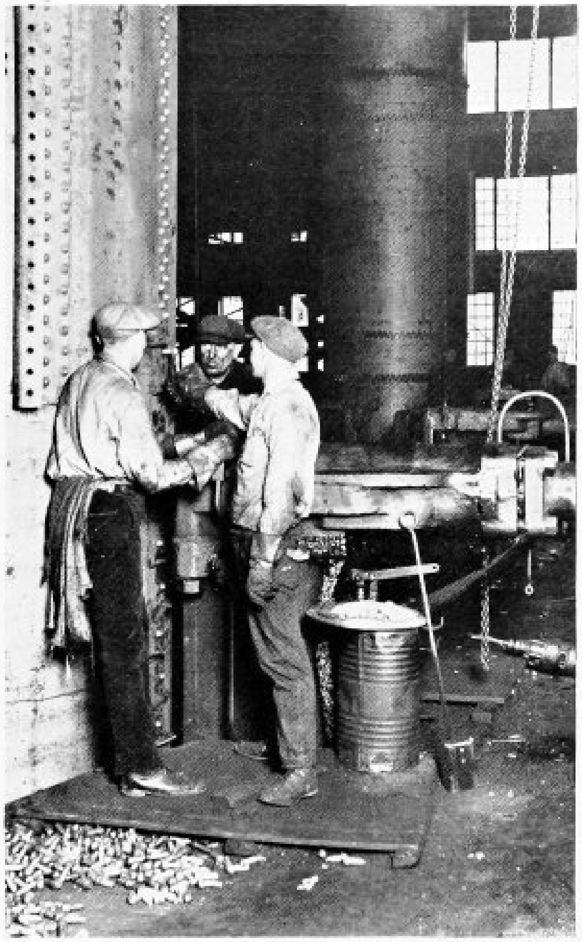


Fig. 2.—Hydraulic riveting pure nickel rivets

The annealing it will be noticed from the above tests has increased the ductility of the plate and this increase in ductility would be considerably greater in thinner gages; so that thin gage plates subject to severe forming or drawing operations should without doubt be annealed.

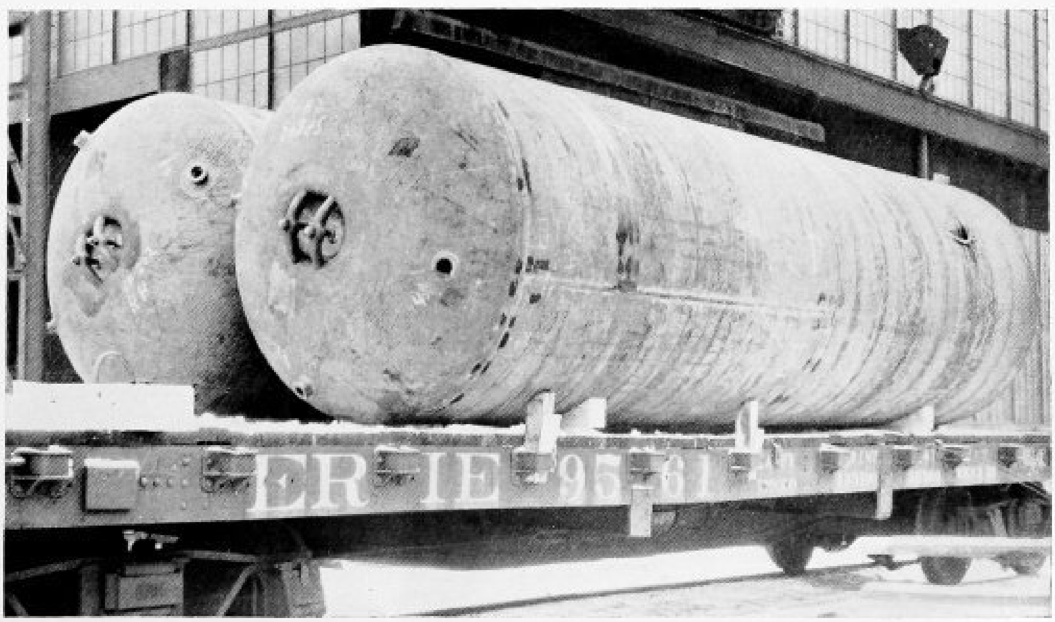


Fig. 3.—Fusion-welded pressure vessels, 72 inches diameter by 23 feet long, built of 20 percent nickel clad steel plate. A.S.M.E. Class 1 construction including X-rayed joints and stress relieving

TABLE 1.—LUKENS NICKEL-CLAD STEEL—10 PERCENT TO 20 PERCENT CLADDING, ONE SURFACE
Thicknesses, Widths, Lengths and Diameters of Circles in Inches

LENGTHS IN INCHES

Thickness	WIDTHS 48"	60"	66"	72"	78"	84"	90"	96"	102"	108"	114"	120"	126"	132"	138"	144"	150"	156"	162"	Circular Plates Maximum Diameter
3/16"	480	470	425	390	360	335	315	290	275	260	250	...	...	...	...	...	...	...	...	114"
1/4"	480	480	480	480	480	480	440	410	385	365	345	330	315	300	...	...	...	...	...	132"
5/16"	480	480	480	480	480	480	480	480	480	480	470	450	430	410	390	370	360	...	...	150"
3/8"	480	480	480	480	480	480	480	480	480	460	435	415	395	375	360	345	330	315	300	162"
7/16"	480	480	480	480	480	480	480	445	420	395	375	355	340	320	310	295	285	270	260	162"
1/2"	480	480	480	480	480	480	440	385	365	345	325	310	295	280	270	260	250	240	230	162"
9/16"	480	480	480	480	460	425	390	345	325	305	290	275	260	250	240	230	220	210	205	162"
5/8"	480	480	480	450	410	380	350	310	290	275	260	250	235	225	215	205	200	190	185	162"
11/16"	480	480	445	405	375	350	325	280	265	250	235	225	215	205	195	185	180	170	165	162"
3/4"	480	450	410	375	345	320	300	260	245	230	215	205	195	185	180	170	165	160	150	162"
7/8"	420	380	350	320	290	270	250	220	210	195	185	175	170	160	155	145	140	135	130	162"
1"	335	335	305	280	260	240	220	195	180	170	160	155	145	140	135	130	125	120	115	162"

COLD WORKING

Cold operations such as bending, flanging, forming, shearing, beveling, and the like are performed exactly as in common steel plate work. No change in equipment or provision for special tools is required. Whenever possible, nickel-clad steel plates should be handled around the shop and to the shears and punches with the nickel side up, to prevent gouging and deep scratching of the cladding. Shearing and punching are best done to throw the burr on the steel side. Severe cold operations, such as pressing heads and die work, generally require annealed plate.

ANNEALING FOR COLD PRESSING

Proper annealing to condition the nickel for severe cold work is satisfied by heating the plate to 1600-1700 degrees F., holding at heat from one to three minutes, drawing from the furnace, and allowing the plate to cool in the air. The furnace is brought up to the required annealing temperature before charging the plate. The burners are adjusted to give a reducing atmosphere to prevent excessive oxidation.

The instructions, given under "Heating for Hot Working," must be observed even more faithfully in annealing for cold pressing to preserve the nickel from loss of ductility through sulphur or oxygen embrittlement.

HEATING FOR HOT WORKING

Given the proper means of heating nickel-clad steel plate, no change need be made over usual steel practice as to temperatures, amount of work done on each heat, or the methods used in performing the work. Nickel-clad steel should be heated in furnaces designed to provide complete combustion of the fuel before the hot gases strike the metal. A reducing atmosphere should be maintained by adjusting the fuel-air mixture to give an excess of carbon monoxide and avoid excessive oxidation. The stack dampers should be adjusted to maintain a positive pressure within the furnace to prevent an intake of air under the door and through other openings.

The plate should be supported on clean steel rails or clean firebrick, to keep the nickel from contact with slag and cinder on the furnace bottom which may be the cause of damage through embrittlement. Whenever possible, the plates should be heated with the nickel side up.

Fuels high in sulphur, such as coal, coke, unwashed producer gas, crude oil, and others having a sulphur content in excess of 0.5 percent, may destroy the ductility of the nickel through embrittlement and their use is to be avoided. Satisfactory fuels for plate work are those having a sulphur content not over 0.5 percent. Among these are natural gas, light distillate oils, butane, propane, acetylene, city gas, kerosene, gasolene, charcoal, "blacksmith" coal, and coke from coal treated to reduce the sulphur to under 0.5 percent. Damage to the nickel may often be prevented when combustion and fuel conditions are not entirely suitable by covering the nickel surface with a lime wash or asbestos sheeting.

Heavy-duty preheating torches burning light distillate oil, or large acetylene welding torches, provide satisfactory means of heating for localized hot work. The flame should be directed against the steel side of the plate whenever conditions will permit.

If it is necessary to apply the flame against the nickel, it is desirable to use oxy-acetylene torches adjusted to give a slightly reducing flame.

The rapid loss of heat to the surrounding air makes it difficult to heat heavy plate to the required temperature

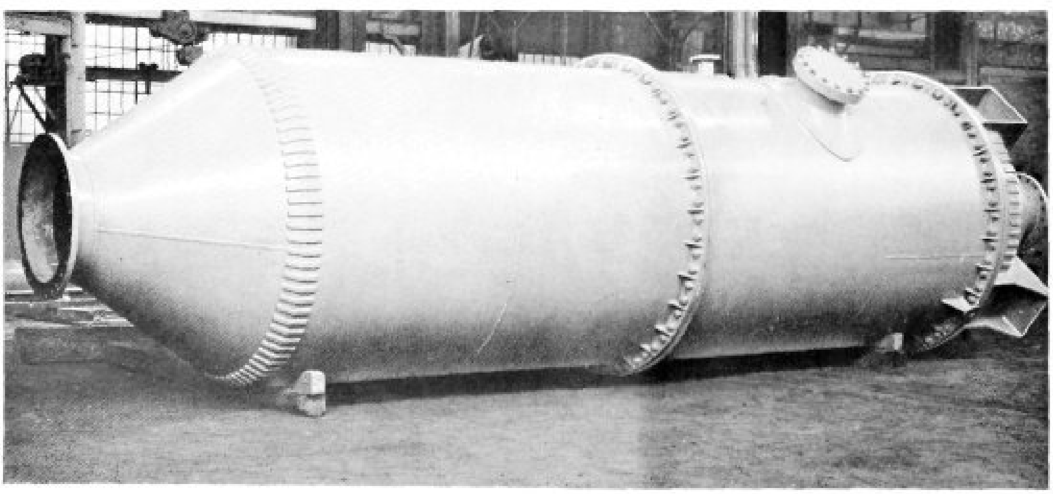


Fig. 4.—Nickel-clad steel high concentration evaporator, 84 inches diameter by 30 feet high. Arc welded construction

Fig. 5.—Nickel-clad steel tank car of 8000 gallons capacity used in transporting phenol for plastics

even with large preheating torches. An improvised furnace of loose firebrick usually can be assembled to confine the heat and allow for proper combustion conditions.

Surface Cleaning

During transportation and handling in the fabricator's shop, small particles of iron, often in the form of dust and mixed with grease, collect on the nickel surface. The clean appearance of the nickel surface can be restored by the following procedure:

(1) remove any grease with a commercial solvent or a hot caustic cleaning solution, and blast with sand at pressures not exceeding 35 pounds. If sand blasting equipment is not available, first remove the grease and then wash and scrub the surface with a commercial hydrochloric acid solution in the proportion of one gallon of water to a half to one gallon of acid. This should be followed by a rinse of plain water, which, when wiped dry, will leave the surface of the nickel satisfactorily clean.

Other pickling solutions may be used for cleaning the nickel surface, which are given in The International Nickel Company's bulletin TS-4, "Pickling of Monel Metal, Nickel and Inconel."

Joining

Joints are usually made by welding, the nickel side being welded with nickel welding rod to obtain a continuous nickel surface which protects the steel base plate from corrosion at the joint. A description of recommended welding rods and welding practice follows. These joining methods have been used in the fabrication of several hundred tons of nickel clad steel equipment, the performance of which in service has demonstrated in a practical manner that properly made welds possess corrosion resistance entirely adequate for the purposes to which nickel-clad steel is adapted.

Metallic Arc Welding

Heavy steel plate is generally welded by the metallic arc method, and consequently this is the most important method to be considered in welding nickel-clad steel.

In general, the preferred procedure in welding nickel-clad plate, particularly with beveled butt joints, is as follows: (1) Assemble the vessel by tacking from the

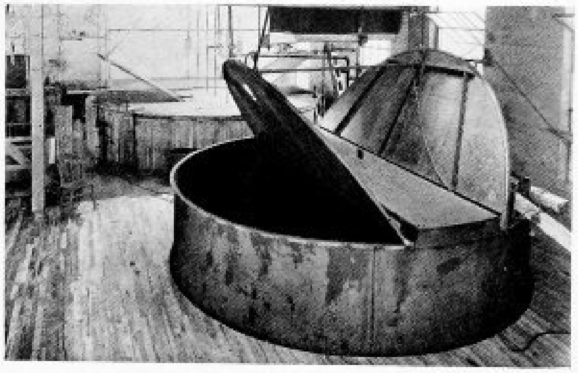


Fig. 6.—Top of nickel-clad steel soap-boiling kettle, 15 feet diameter by 29 feet deep. Joints lapped, wide space riveted and welded

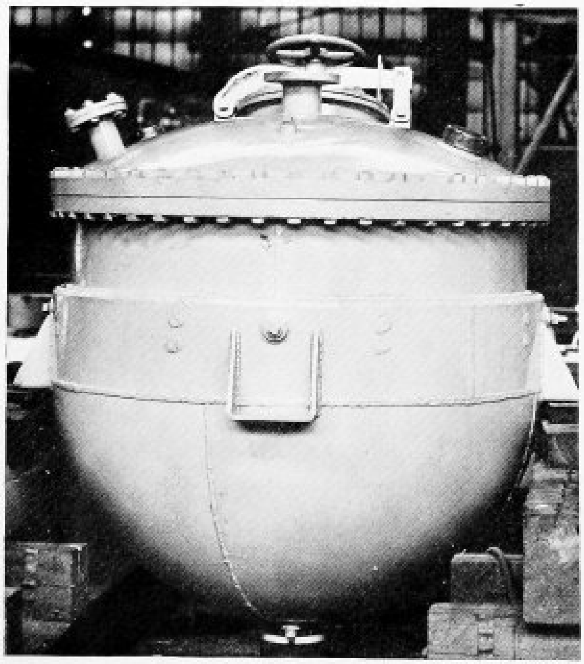


Fig. 7.—Jacketed kettle for plastics. Steel outer jacket 20 percent nickel clad. All seams arc welded

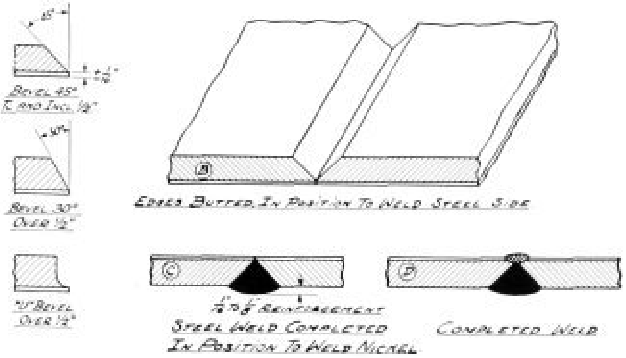


Fig. 8.—Butt welded joint, metallic arc welded

steel side. (2) Complete the weld on the nickel side with a single bead. (3) Chip out the tacks and clean to the root of the bevel. (4) Complete the weld on the steel side.

In shops where beveling is done by hand chipping, it is usually desirable to weld the steel side first to avoid the possibility of burning through, uneven welding, and other difficulties arising from variations in the separation of the joint and the thickness of the lip at the root of the bevel.

The accustomed practices prevailing in the shop, including size and type of welding rod, current adjustment, and manipulation peculiar to individual operators, are used without important modifications in welding the steel side of the plate.

The skilled operator should have no difficulty in welding the nickel side. Operators inexperienced in the welding of nickel should study the instructions distributed by The International Nickel Company on the welding of solid nickel plate, and then should make a sufficient number of test welds to enable the adjustment of their manipulation to suit the characteristics of nickel welding. The principal points to be observed in the preparation of the joints, assembly, and welding, are:

(1) The edges of the plate should be planed to give uniform alinement at the joint.

(2) Beveled butt joints should be assembled as shown in Fig. 8, with the edges of the bevel at the lip closely butted.

(3) On joints welded first from the steel side, the nickel side should be cleaned free from "icicles," slag, and heavy oxide. It is advisable to chip the seam with a round nose chisel to a depth necessary to expose sound metal at the root of the steel weld.

(4) Use Inco Nickel Metallic Arc Welding Wire, No. 35, for welding the nickel side. These electrodes may be procured from the sources of supply for Inco products in sizes 3/32 inch to 3/16 inch diameter by 18 inches long, packed in five-pound bundles.

(5) The operator should make trial welds with reversed polarity at several current values, and select the amperage that best suits the nature of the work and his own manipulative methods.

(6) The short arc, 1/16 inch to 1/8 inch long, is an absolute necessity.

(7) The selection of the size of electrode and the adjustment of the welding current must properly balance the penetration and rate of electrode fusion.

Types of Joint

The beveled butt joint, Fig. 8, should be used whenever the nature of the work allows this type of joint. Field erections of large storage tanks may require the lap joint shown in Fig. 9. The various joints shown in the illustration are used to meet the particular needs of the construction.

Carbon Arc Welding

This is a useful method of welding and can be relied upon to yield strong, dense welds of high ductility. Excellent results have been obtained in welding vertical joints because of the closer control over the rate of fusion and the placement of the deposited metal.

Inco nickel welding electrodes, flux coated for carbon arc welding, 3/32 inch or 1/8 inch diameter are used with carbon rods 1/4 inch or 5/16 inch diameter. The carbons are ground on an emery wheel to a fine point, tapering back one to two inches. They have low-current carrying capacity and the larger welding amperages cause them to reach a white heat. A short grip, 3 to 4 inches long, is taken in the holder to prevent excessive wasting away from oxidation of the carbon and to improve the comfort of the operator.

Straight polarity, i.e., carbon negative, is used. If the operator does not know the direction of current flow, the behavior of the carbon will provide a means to determine the proper circuit connection. Reversed polarity will cause the carbon to become blunt and to burn away rapidly. The crater, characteristic of the positive side of the arc, is usually present. The arc becomes "wild" and difficult to control. On the other hand, a properly connected circuit gives a smooth, quiet arc. The carbon retains the pointed end and operates at a much lower temperature.

The current is adjusted to as small a value as possible to give a steady arc and the proper rate of fusion. The welding rod must not be fed into the arc before the plate is heated sufficiently to melt the surface of the joint, and care must be exercised to keep a wetted surface ahead of the advancing pool of weld metal. Excessive amperage must be avoided to prevent the formation of troublesome craters in the weld or on the plate at the point where the arc is broken.

Carbon arc welding will often prove useful in welding light gage linings in outlet fittings, manholes, and other sheet metal in conjunction with plate work, and data on suitable current values are included in the following table for this purpose.

Plate thickness, inch	Carbon diameter, inch	Amperage	Filler rod diameter, inch
.062–.125	1/4	50– 80	3/32
.125–.187	1/4	80–100	3/32–1/8
3/16–1/4	5/16	90–120	3/32–1/8
1/4–3/8	5/16	100–125	1/8
3/8–1/2	3/8	110–150	1/8

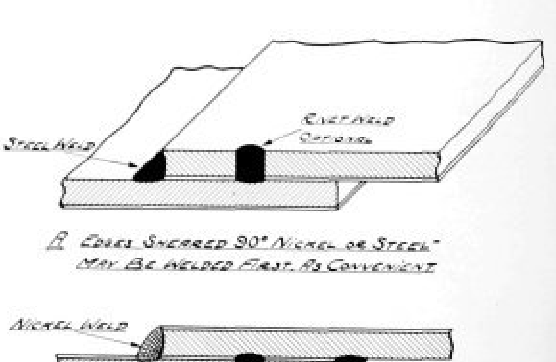


Fig. 9.—Lap welded joint, metallic arc welded

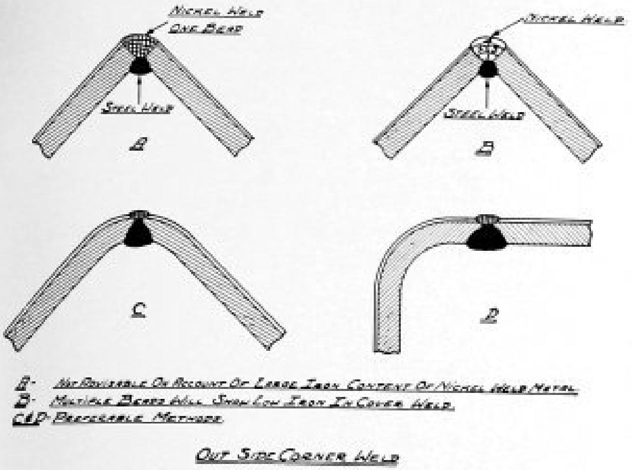


Fig. 10

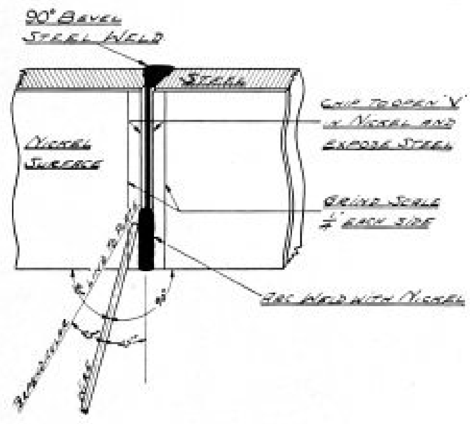


Fig. 11.—Vertical welding—metallic arc

Acetylene Welding

The results of an investigation made in the research laboratories of the Linde Air Products Company on acetylene welding of nickel-clad steel plate have established gas welding as an excellent method of joining and one particularly well adapted to vertical welding.

The results of tensile and bend tests (average of two tests) on gas welds on $\frac{1}{4}$ inch plate clad 10 percent were as follows:

Yield point, pounds per square inch	Tensile strength, pounds per square inch	Elongation convex side weld metal, percent	
		Nickel	Steel
39,300	64,500	20	30

(Fracture occurred $1\frac{1}{2}$ inches outside of weld)

The beveled butt joint is the best type for general use, but other types common to steel plate welding can be expected to give equally good results with the possible exception of the outside corner weld, Fig. 10A, which may be very high in iron.

The use of multiple layer welding, to reduce the iron content of the weld metal, as shown in Fig. 10B is not advisable with acetylene welding and the outside corner joints shown in Figs. 10C and 10D are the best types to use.

The steel weld is usually made first, then the nickel weld. No change is made in welding the steel side over the accustomed practice in welding solid steel plate. In acetylene welding the nickel, the all important rule, "maintain a slightly reducing flame," must be observed. The sharp flame that yields entirely satisfactory welds in steel will give brittle and spongy welds in nickel.

Inco nickel gas welding wire is used. This wire is supplied in 36-inch lengths and is used bare. Gas welding flux should not be used.

The reducing flame with a given tip size and acetylene pressure is not as intense as the sharp flame and a tip one size larger than the tip used under steel welding conditions may be required. With the larger tip, both the acetylene and the oxygen pressures should be reduced to give a soft, easy flame.

Atomic Hydrogen Welding

The atomic hydrogen method is adaptable to the welding of nickel-clad steel plate, both on the steel side and on the nickel side, without change in any respect over the welding of an equivalent joint in common steel. The welds are of excellent quality and except for the possible higher welding costs over other methods, it is highly satisfactory.

The preparation and assembly of the joints and procedure in welding follow closely the descriptions given under the electric and gas welding methods. The welding wire may be the bare Inco gas welding rod or the Inco flux-coated electric welding wire as used for carbon arc welding. It is the writers' opinion, from observation of several tests, that the flux-coated wire gives slightly better welds than are obtained with bare wire.

A small welding rod, $\frac{1}{16}$ inch or $\frac{3}{32}$ inch diameter, is desirable except for plate over $\frac{1}{2}$ inch thick, or for heavy fillet welds for which the large $\frac{1}{8}$ inch or $\frac{5}{32}$-inch diameter rod can be used.

Position Welding

In the erection of large storage tanks in the field, the tank cannot be kept in a position to weld all joints "down hand," as is possible in shop assembly. The operator must therefore be prepared for vertical, horizontal, and, in rare instances, overhead welding. Vertical welding on the nickel side is readily accomplished and welds equally as good as "down hand" welds are obtained. This type of work is done usually by companies organized and experienced in handling the many details of outside erections, and their welders are skilled in this class of work. The welding of nickel may be new to them, but by practice the average good welder will soon learn the manipulation that yields proper welds.

Metallic Arc. A greater degree of skill is required in vertical welding with the metallic arc than with the carbon arc, oxy-acetylene, or the atomic hydrogen methods. The deposition of the metal is effected by the adhesion and surface tension between the globule of molten metal on the end of the electrode, and the film of molten metal on the surface of the plate.

Vertical welding is started with a deposit at the bottom to form an almost horizontal face or shelf. The electrode is inclined as shown in Fig. 11, and fusion at the base of the weld is kept slightly ahead of the outside. The size of electrode and current setting must be determined by careful trial.

Horizontal welding with the metallic arc is accomplished by applying the same principles as in vertical welding. The shelf is inclined at an angle of about 45 degrees from the vertical and the fusion of the lower portion is kept in advance of the upper portion. The position of the electrode is downward and to the side in a back-hand direction to the advancing weld.

A special flux coating is used on electrodes for position welding by the metallic-arc process.

Carbon Arc. Fig. 12 illustrates the position of the carbon pencil and the electrode in vertical welding. Carbon pencils $\frac{1}{4}$ inch diameter with flux coated electrodes $\frac{3}{32}$ inch diameter are used on plates up to $\frac{5}{16}$ inch thick, and $\frac{5}{16}$ inch carbons with $\frac{1}{8}$ inch electrodes for heavier plate. The current is adjusted by trial to suit the plate thickness and to effect prompt fusion of the base metal, but not so high that deep craters form on breaking

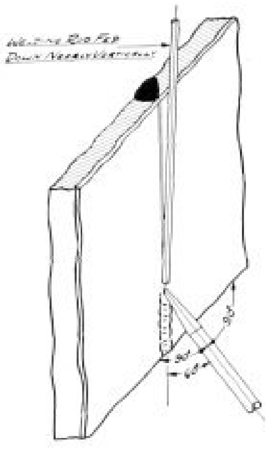
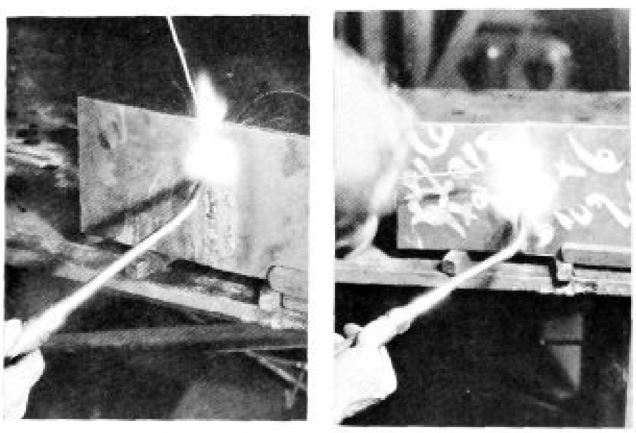


Fig. 12.—Vertical welding—carbon arc

the arc. The end of the welding rod is admitted into the arc stream just after the glossy film of molten metal shows on the plate and the face of the weld. The small diameter weld rod melts promptly, and the metal is deposited smoothly and evenly.

Acetylene and Atomic Hydrogen. The welding of vertical and horizontal joints with the acetylene or the atomic hydrogen torch is almost as simple as "down



Steel Side Nickel Side

Fig. 13.—Acetylene welding a vertical seam, showing the proper position of the torch and weld rod

hand" welding. The selection of the tip size, gas pressures, and welding rod in acetylene welding follows closely those given for "down hand" welding with the exception that a smaller rod should be used as shown in Fig. 13.

Atomic hydrogen will present the same conditions that apply in oxy-acetylene welding. The most intense portion of the fan is directed into the root of the weld, and the filler rod added in the same manner as in gas welding.

Peening Welds

Peening or bobbing to compact the nickel-weld metal is desirable. The weld is improved in density, physical strength, corrosion resistance, and appearance. Pneumatic chipping hammers are used with flat-faced tools slightly rounded at all corners. The tool is held squarely against the weld and moved back and forth laterally and across the weld with a rocking motion to conform to the curvature of the weld. Sharp-cornered tools that may cut into the nickel along the line of the weld must be avoided.

Forge Welding

Forge welding by the methods used with steel cannot be accomplished with nickel-clad steel except by machining off the nickel to a width well outside the lap and, after joining the steel, arc welding a solid nickel plate over the exposed steel to provide a continuous nickel surface.

Riveted Joints

Riveting as a means of joining will be necessary only when codes or regulations prohibit the welded joint. Lap-riveted joints were used in the construction of the railroad tank car to meet the specifications for cars in this class. The rivets are pure nickel and the inside exposed steel edge of the lap is protected with nickel applied by metallic arc welding. Riveting and calk welding is a practical means of joining, but for nearly every class of equipment where nickel-clad steel is adaptable, especially in chemical process equipment, the welded joint is to be preferred. The continuity of the nickel surface is more easily accomplished with welded joints. Welding is mechanically safe for all but a few extreme conditions of service, and a welded joint is equal in corrosion resistance to the riveted joint. A further advantage of welding over riveting is in the cost economy of labor and material.

The simple lap joint, either single or double riveted, is the type most apt to be selected when welded joints are not permissible. The strapped butt joint with nickel straps against the clad surface may be used to meet special conditions of service though the cost is rather high.

Riveted joints are designed, the plates are beveled, and the holes drilled or punched and reamed in the same manner as for steel plate. The heating of the rivets, however, requires precautions to protect the nickel against injury from sulphur attack and excessive oxidation. Rivet heating in a forge burning gas, kerosene, light distillate oils, or similar low-surphur fuels will yield satisfactory results when conducted in a definitely reducing atmosphere.

The proper temperature for hand-driving with pneumatic riveting hammers is 1950-2100 degrees F. (orange yellow to light yellow). Lower temperatures are generally preferred in hydraulic riveting, e.g., 1400-1500 degrees F. The only precaution that need be observed in driving at these low temperatures is to anneal the metal by holding the rivets in the forge about five minutes at temperature.

(To be continued)

Westinghouse Elects New Directors

At the annual meeting of stockholders of the Westinghouse Electric & Manufacturing Company, held at the home office of the company in East Pittsburgh, Thomas I. Parkinson and George A. Ranney were elected new directors of the company.

High temperature requirements extend

Use of Alloy Steels in Boiler Drums*

By G. K. Herzog†

The necessity for generating power at the lowest possible cost has forced engineers and designers to study every possible economy. In a plant generating steam power, one of the largest items of expense is the cost of fuel, and for years efforts have been directed towards obtaining greater fuel efficiency and consequent lower fuel costs.

The problem of lower fuel costs has been attacked from various angles and much progress has been made through improvements in boiler design and the use of economizers, preheaters and stokers, and also through the use of powdered, liquid and gaseous fuels. A large part of the improved fuel economy of modern steam generating plants is, however, due to the use of higher steam pressures and temperatures. At the present time the optimum steam pressure and temperature for greatest over-all economy has not been determined. In so far as the optimum temperature is concerned, it is more than likely that this lies substantially above those now used in even the most modern high temperature installations.

Until about five or six years ago, 750 degrees F. was considered the practical upper temperature limit for superheated steam. This involved some problems that were not encountered when working at lower temperatures, but these problems have for the most part been satisfactorily solved. Since that time a number of stations operating at temperatures of 825 degrees to 850 degrees F., and at least one operating at a temperature of 1000 to 1100 degrees F., have been built in this country. Just how much higher these temperatures can economically go depends on the ability of the metallurgist to develop suitable steels.

As long as temperatures did not exceed approximately 750 degrees F. the plain carbon steels were satisfactory, at least as regards the necessary strength at the temperature used, and they can probably be used with a reasonable degree of success for temperatures as high as 900 degrees F. However, they do not possess those properties required for satisfactory operation for long periods at high temperatures and it is necessary to use alloy steels in such applications.

Until a relatively few years ago a knowledge of the physical properties of a steel determined at room temperatures was considered all that was necessary for the proper design of a piece of apparatus, regardless of the temperature at which it was to be operated. In some cases where the apparatus was to operate at a somewhat higher temperature than customary the physical properties determined at the operating temperature were used as a basis for design. Today other factors must be taken into account, one of the most important of which is the so-called limiting creep stress, or as some prefer to call it, the creep strength.

Creep strength is a subject that is being widely discussed by designers of pressure apparatus that must operate at elevated temperatures. There is as yet no general agreement as to the best method of determining creep strength, nor to the weight that should be given to creep strength determinations in the design of high temperature pressure apparatus, but engineers and designers are agreed that it must be taken into consideration.

The terms creep, creep strength and limiting creep stress as applied to steel are relatively new and it might be well to describe briefly just what they mean. When a piece of steel is subjected to a stress it is strained or deformed. If the stress is applied at room temperature and does not exceed the elastic or proportional limit, strain or deformation is proportional to the applied stress and is apparently entirely independent of time. When the stress is removed the piece of steel returns to its original size, that is, it behaves for all practical purposes as though it were a perfectly elastic body.

At elevated temperatures the behavior is somewhat different. Even relatively low stresses will result in a deformation that increases with the length of time the stress is applied. When the stress is removed the piece of steel does not return to its original size but has been permanently deformed. This is the phenomenon now generally known as creep. It may thus be defined as the permanent elongation or plastic flow which occurs in a metal which is subjected to a stress and which increases with the time of application of the stress.

The ability of a metal to withstand creep is designated as limiting creep stress or creep strength. It is usually expressed as the maximum stress which will cause a plastic flow or permanent deformation not exceeding a certain amount in a specified number of hours at a definite temperature. It is frequently expressed as the stress which will cause a permanent elongation of not more than 1 percent in 10,000 hours at any particular temperature. For the design of some equipment, it seems desirable to express it in terms of 1 percent in 100,000 hours and this figure is favored by those desiring to be conservative. In many applications the creep strength is of minor importance but in pressure vessels operating at high temperatures it becomes of extreme importance and in many cases it is the factor which determines the design of the apparatus.

While creep strength is of the greatest importance, a material to be satisfactory for service at elevated temperatures must have other suitable properties. It must possess satisfactory tensile and fatigue properties and impact strength and must be capable of withstanding corrosion and oxidation at the temperature at which it will be used. It must be capable of being fabricated into the required apparatus at a reasonable cost and it must not deteriorate structurally when exposed for a long time to the given operating conditions.

Modern metallurgy has kept pace with power plant design and is prepared to furnish the materials required for the economical construction and operation of these new high-pressure, high-temperature installations. As in

* Abstract of paper presented at the tenth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors.

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so many other modern engineering developments, the answer is—alloy steels.

Alloy steels suitable for high temperature uses were developed largely to satisfy the needs of the oil refining industry which resulted from the growth in the use of the cracking process for the production of gasoline. Oil cracking equipment, particularly tubes, has a relatively short service life due to three factors—corrosion, oxidation, and creep. These are the very same factors that are of the greatest importance in high-pressure, high-temperature steam equipment and it is not at all surprising that the same steels found satisfactory in the oil industry should also find application in the steam power industry.

The alloying elements found most useful for steel suitable for high-temperature, high-pressure steam equipment are chromium, molybdenum, tungsten, vanadium, manganese, silicon and nickel. The use of titanium, columbium, and nitrogen in high chromium steels is the subject of much experimental work at the present time and indications are that steels containing these elements will find extensive use in high-temperature, high-pressure equipment. Each of these elements exerts very definite influences on the steel to which it is added, but the effect of each is modified by the presence of other elements and it thus becomes of the greatest importance to obtain a proper relation between the amounts of the varying alloying elements in order to obtain best results. Alloy steels in which the proportions of the various elements have been chosen so as to give the best possible combination of the required physical and chemical properties are now known as balanced alloy steels.

Chromium is present in practically all steels designed to be used at high temperatures. It increases strength, hardness, oxidation and corrosion resistance and creep strength. For extreme resistance to corrosion and oxidation at high temperatures a large percentage of chromium is absolutely essential. All of the so-called stainless or corrosion-resistant steels contain high percentages of chromium, usually in excess of 12 percent and occasionally more than 30 percent. Chromium when present in certain percentages may cause undesirable air-hardening properties, and titanium or columbium are added to overcome these and at the same time retain, and even improve, the corrosion and oxidation resistance of these steels. Certain of the high-chromium steels exhibit a coarse grain structure which adversely affects their hot working qualities and physical properties. It has been found that nitrogen is effective in refining the grain and improving the physical properties of these steels.

Molybdenum when added alone to a plain carbon steel is probably the most effective of the elements in improving the creep strength. When added to the chromium steels, such as for instance, those containing about 4 to 6 percent of chromium, it likewise acts to somewhat increase the creep strength and probably has a slightly favorable effect on corrosion resistance. It is also effective in increasing the corrosion resistance of some of the high chromium-nickel steels, such as the stainless steel commonly known as "eighteen-eight."

Tungsten acts very much like molybdenum in steels suitable for high-pressure, high-temperature equipment. Because of the fact that in the 4 to 6 percent chromium steels about twice as much tungsten as molybdenum is required to obtain a certain effect, molybdenum is generally favored over tungsten for these steels, largely because of cost. However, in steels of other compositions tungsten is apparently fully as effective as molybdenum and may even have certain advantages.

Vanadium increases creep strength and is particularly effective in producing a fine grain structure and in increasing the impact strength and fatigue values. It also improves the welding qualities of some of the low alloy steels.

Nickel when present in relatively small amounts is effective mainly in giving increased strength and toughness. It is the element most commonly used to produce the so-called high-chromium austenitic steels which have properties that differ essentially from those of the usual alloy steels. The austenitic steels containing, for example, approximately 18 percent chromium and 8 percent nickel are non-magnetic and cannot be hardened by heat treating. They are extremely resistant to many corrosive substances and oxidation at high temperatures, can be cold worked so as to exhibit very high physical properties and yet retain sufficient ductility to enable them to be readily fabricated while cold. Manganese is usually added to increase strength and in some cases to give improved hot working properties. Silicon likewise results in added strength and in increased resistance to scaling at high temperature.

Frequently after the maximum benefit that can be obtained from the addition of one of the alloying elements has been reached, a further improvement can be obtained by the addition of one or more other elements. This is, at least in part, an explanation why some of the more or less complex alloy steels have been developed.

It is not the intention to go into great detail in this paper regarding the physical properties of the various steels that have been used or proposed for high temperature steam equipment but rather to indicate, in a general way, in just what manner and to what extent the necessary physical and chemical properties of steels have been improved in order to make them suitable for this type of service. Some of these steels have been approved by the various committees of the national engineering societies and other bodies regulating the use of materials in pressure vessels, tentative specifications have been drawn for others but not yet officially adopted, while others are still in the development stage but give every promise of proving satisfactory.

Chromium-Nickel—18 percent Chromium, 8 percent Nickel. Of the commercial steels now available, the steel containing approximately 18 percent chromium and 8 percent nickel has probably the best combination of properties making it suitable for the most severe high-pressure, high-temperature service. The chemical composition of this steel varies somewhat with the use to which it is to be put. In general, it contains from 17 percent to 20 percent chromium, 7 percent to 10 percent nickel and under 0.25 percent carbon. In order to prevent the embrittlement to which it is subject when exposed to corrosive action at temperatures from 900 degrees to 1500 degrees F., titanium or columbium is frequently added in order to stabilize and make it practically immune to such action. Molybdenum is sometimes added to obtain increased resistance to the corrosive action of some chemicals; tungsten and silicon for improved high temperature properties. This steel is extremely resistant to corrosion and oxidation and has, relative to plain carbon steel or the low alloy steels, a very high creep strength. It will, for example, resist scaling indefinitely at a temperature as high as 1700 degrees F.

High Chromium-Tungsten Steel. A steel containing 12 percent to 16 percent chromium and 2.5 percent to 3.0 percent tungsten also possesses properties which should make it excellent for high temperature steam service. Because of its high chromium content, it shows excellent resistance to scaling at high temperature, has good resistance to corrosion, and possesses good creep strength.

Chromium Steel, 4 percent to 6 percent—with Molybdenum or Tungsten. A relatively low alloy steel, one containing about 4 percent to 6 percent chromium and usually either 1 percent tungsten or ½ percent molybdenum, has found extensive use in the oil cracking industry and should prove an excellent steel for superheater tubes in high temperature steam installations. This steel has a creep strength approximately double that of plain carbon steel at a temperature of 1000 degrees F. and, in addition, is much more resistant to scaling and corrosion than plain carbon steel at temperatures up to at least as high as 1200 degrees F. It has been used for a variety of equipment operating at high temperatures, particularly in tubes and valves, and has given excellent service. The air hardening characteristics of this steel can be entirely eliminated by the addition of titanium or columbium and this will no doubt greatly increase its field of usefulness.

Chromium-Molybdenum Steel. A chromium molybdenum steel containing 0.15 percent carbon, 1 percent to 1.5 percent chromium, about 0.5 percent molybdenum, and 1 percent silicon, possesses a creep strength of 15,000 pounds per square inch for a creep of 1 percent in 100,000 hours at 1000 degrees F., which compares very favorably with that of the high alloy 18 percent chromium, 8 percent nickel steel mentioned above. Its resistance to oxidation is not high but is substantially better than that of plain carbon steel. At 1000 degrees F. it is about equal to that of the 4 percent to 6 percent chromium steel containing molybdenum; at higher temperature it is comparatively somewhat lower.

Carbon-Molybdenum Steel. Another of the low alloy steels which possesses good high temperature physical properties is a carbon-molybdenum steel containing approximately 0.10 percent to 0.20 percent carbon and 0.45 percent to 0.65 percent molybdenum. At 1000 degrees F. this steel exhibits a creep strength several times that of plain carbon steel. At 1200 degrees F. it is approximately twice that of plain carbon steel. Its resistance to corrosion and oxidation at high temperatures is approximately the same as that of plain carbon steel and it can therefore be used to advantage only when these conditions are not severe.

Manganese-Molybdenum Steel. A manganese-molybdenum steel containing approximately 1.25 percent manganese and 0.25 percent molybdenum possesses an exceptionally high creep strength at temperatures up to about 900 degrees F. and an excellent creep strength at even higher temperatures. Its resistance to corrosion and scaling are about the same as those of plain carbon steel. It has been recommended for steam piping operating at temperatures not to exceed 1000 degrees F.

Chromium-Aluminum Steel. In Germany a chromium-aluminum steel, the composition of which varies quite widely with the service to which it is to be put, seems to be giving excellent service in superheater tubes. Such tubes are reported to be giving entirely satisfactory service at steam temperatures of 900 degrees to 1000 degrees F. and pressures of 15,000 pounds per square inch.

Chromium-Manganese-Silicon Steel. An alloy steel not especially designed for high temperature service, but which nevertheless has excellent properties at moderately high temperatures, is one containing approximately 0.4 percent to 0.6 percent chromium, 1.10 percent to 1.40 percent manganese, and 0.6 percent to 0.9 percent silicon. This steel has been approved by the Boiler Code Committee of the American Society of Mechanical Engineers as Specifications S-28 for the construction of riveted or seamless pressure vessels. Short time tests indicate that it has a creep strength approximately 50 percent higher than that of plain carbon steel at a temperature of 1000 degrees F. Its resistance to oxidation at elevated temperatures is definitely better than that of plain carbon steel but it is not of the same order as that of the higher alloy steels.

In addition to the steels which are suitable for boiler drums, superheater tubes, and steam pipes operating at high temperatures, there are a number of alloy steels which are well adapted for use in other parts of the power plant equipment.

Bolts for high temperatures, high pressure service are a real problem. They must be heat treated in order to have the necessary high strength and they must not lose this strength at the temperature at which they are to be used. Several alloy steels are proving satisfactory for this type of work. Probably the most satisfactory steels for this application are the chromium-molybdenum steels containing from 0.5 percent to 1.5 percent chromium and from 0.20 percent to 0.60 percent molybdenum.

Nickel-chromium-molybdenum, chromium-nickel and nickel-molybdenum steels of various compositions have also proved satisfactory. The addition of tungsten and vanadium to some of these steels has still further enhanced the advantages they possess for high temperature work but it is obviously impossible to go into details regarding so many modifications.

The problem of metals suitable for use at high temperatures is an exceedingly complicated one and cannot be adequately discussed in a short paper. Industry is demanding materials to withstand ever increasing temperatures, pressures and corrosive conditions, and the steel maker and metallurgist are co-operating to satisfy this demand. That they have been successful in the past is obvious and there is every reason to believe that they will continue to adequately service the need of industry in the future.

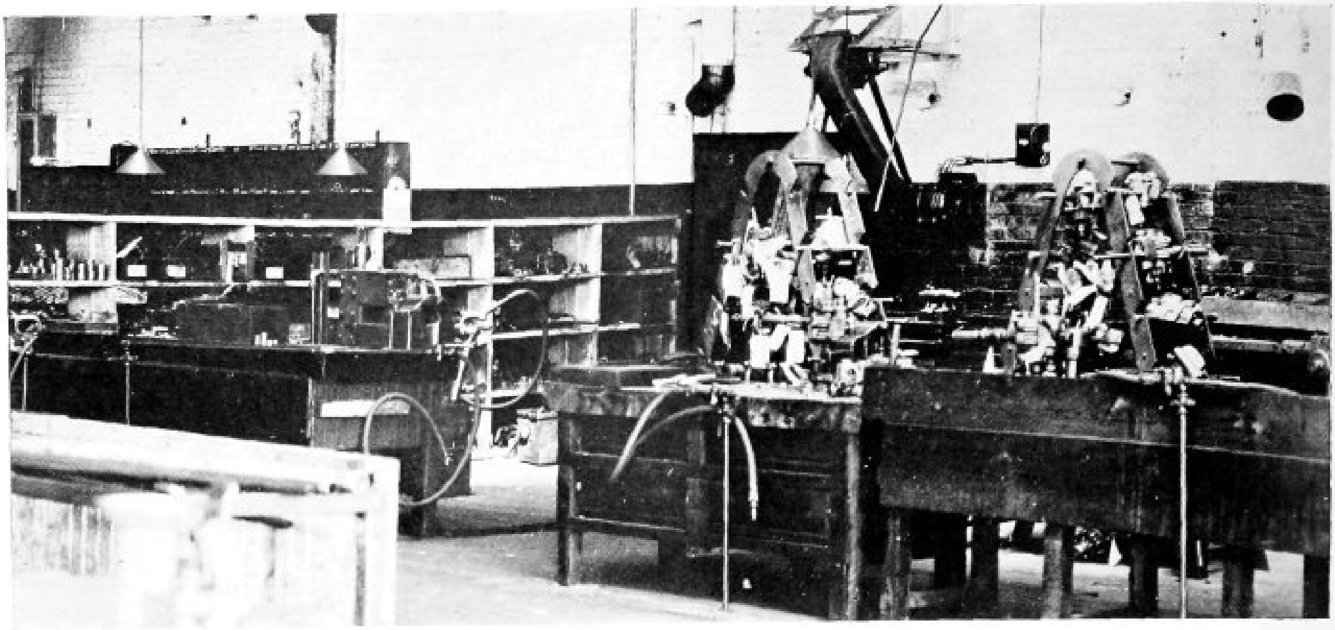
Boiler and Regulator Sales Forces Combined

Announcement is made by Foster Wheeler Corporation and General Regulator Corporation that a consolidation of the sales departments of the two companies has been completed. The distribution of General Regulators will be made hereafter through the branch offices and agents of Foster Wheeler Corporation and all communications on the subject may be addressed to them. The sales headquarters of the General Regulator Corporation will be at the general offices of Foster Wheeler Corporation, New York.

Mr. C. J. King, who has been identified with the General Regulator Corporation since it was organized, will direct this work from New York as in the past. Due to the broader contacts thus established, it is believed that a more widespread service will be rendered customers of the General Regulator Corporation, and that a more comprehensive distribution will be established throughout the country.

Noland Company, Inc. Washington, D. C., has been appointed Toncan Iron sheet distributors, according to an announcement by N. J. Clarke, vice-president in charge of sales of the Republic Steel Corporation, Cleveland.

The Steelduct Company, J. H. Collier, president, has removed its general offices to the Republic Building, Youngstown, O.



General view of the pneumatic-tool repair section at Pitcairn shop

Pennsylvania centralizes work of

Repairing Pneumatic Hammers

Repair work on pneumatic tools for the Pennsylvania System is centralized at four regional shops located at Altoona, Pa.; Wilmington, Del.; Pitcairn, Pa., and Logansport, Ind. This article describes the manner of handling repair work on pneumatic hammers at the Pitcairn air-brake repair shop which takes care of the requirements for the Central Region.

Under Pennsylvania practice no specified time is set for tools to be sent to the central shops for repairs. The shopping of such tools is dependent upon their functioning and, when they fail to function properly, they are sent in for repairs. Only minor repairs are permitted at outlying points. These consist principally of (1) cleaning and oiling the main valves; (2) renewal of pistons (on riveting hammers); (3) renewal of the trigger; (4) the regrinding or renewal of the throttle valve and spring. Repairs other than these are handled only at central repair shops such as Pitcairn.

In order to avoid confusion pneumatic tools are handled on what is known as the repair-tag system. A tag consisting of three parts is used for this purpose. On one side of each part are entered the shipping instructions and on the reverse side an identification of the tool shipped and notations as to its defects. One part of the tag is attached to the tool to be repaired; another part is turned over to the stores department; the third part is retained at the shop which ships the tool for repairs. These tags bear serial numbers and provide a valuable record in tracing lost shipments as well as an indication of the last date on which repairs were made to the tools. A record showing the serial numbers of the tools, the dates received and returned, and the nature of the repairs is kept of all tools received at the central shops. When the tools arrive at the shop they are tested (provided they are not broken or damaged) to determine their condition and the extent to which they may be operated. Upon disassembling the tools are given further careful inspection.

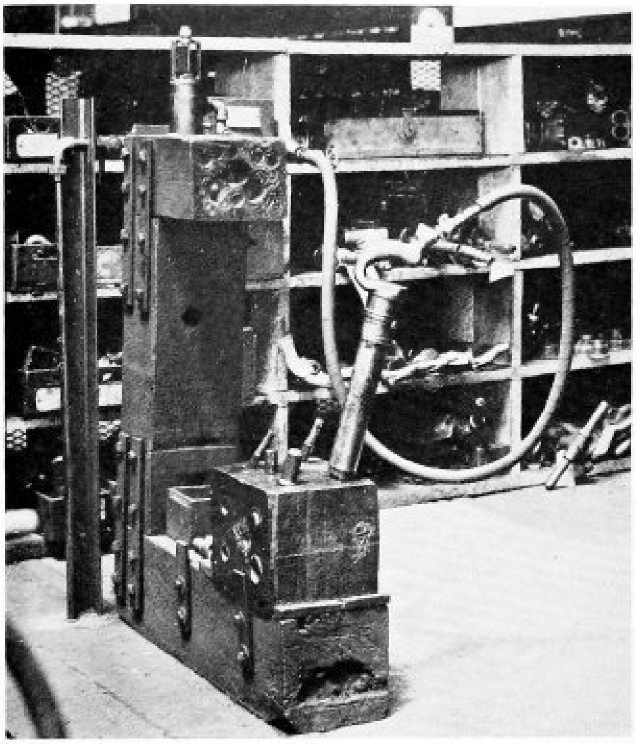
After the initial inspection and testing has been completed the hammers are disassembled and cleaned with a turpentine substitute. One of the first operations consists of removing the valve box. On certain types of hammers, where the handle may be removed from the barrel, a steel rod of suitable size and length is inserted into the piston bore from the nozzle end until it strikes the top of the valve box. A light tap on this rod will usually remove the box complete. Provided the valve-box cap remains in the barrel, it may be removed by striking the handle end of the barrel against a block of wood or lead. On other types of hammers, in which the valve box or guide has a tapped hole, a bolt is screwed into the opening and used as a puller to remove the box or guide from the barrel. In order to disassemble the valve box it is held upside down with the hand gripping the center. The piston end is tapped lightly until the piston and the valve box separate. Particular care must be exercised not to grip the box or cap in a vise or try to pry them apart with a screw driver or similar tool.

When the difference between the diameter of the valve and the bore of the valve block is greater than .001 in., the valve is renewed. When the valve block is broken or worn more than .009 in. larger than standard, it is renewed. Oversize valves are furnished in step sizes of .001 in. to .008 in., inclusive. The bore in the valve block, if considerably worn, is lapped in a center lathe by means of a cylindrical lapping stick, a fine grade of carborundum and oil being used. The valve is lapped to the bore by means of the same abrasive. Pistons that are worn to such an extent that the tool requires excessive air consumption or when they are shorter than standard length are considered unfit for further use.

Riveting hammer nozzles which are worn .010 in. larger than the standard bore are, in some cases, closed in by heating and swaging on a mandrel and then grinding them to the proper size for rivet sets. Another practice is to grind out to fit a .125-in. oversize rivet set. In the case of chipping hammers, when the nozzles are worn .003 in. above standard diameter they are renewed. On riveting hammers the barrels are scrapped when they are worn .006 in. over the standard bore at the handle end. Chipping-hammer barrels are reground to the size necessary to true them up and new pistons are lapped in, although when the bore has been enlarged by grinding to such an extent that further enlargement is prohibitive, the barrel is considered unfit for further use.

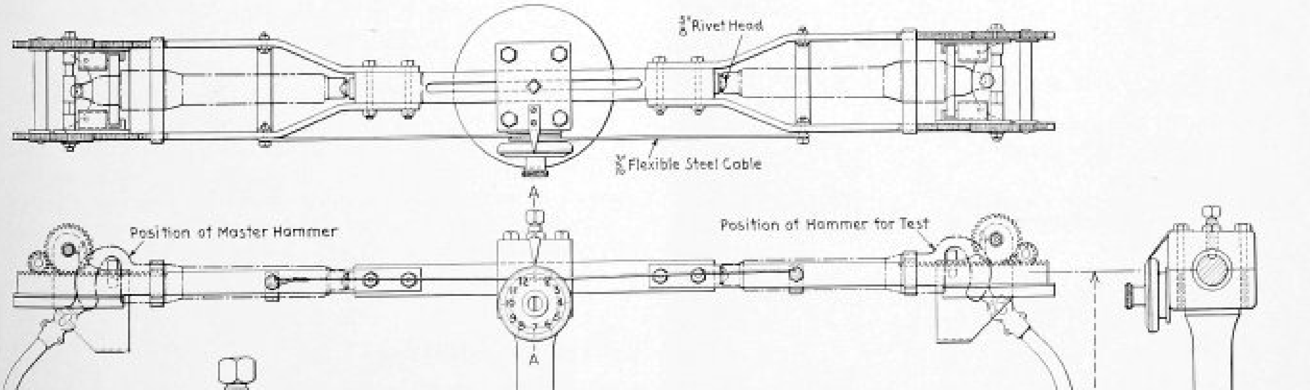
The welding, by the oxy-acetylene method, of cracked barrels is practiced to a limited extent. Sometimes it becomes necessary to face the valve-block bearing in the barrel in order to aline it to the bore. This is accomplished by the use of a special reamer. On that type of hammer on which the handle is bolted to the barrel there is a ground joint between the handle and the barrel. Particular care must be exercised to see that this joint is not damaged and, if necessary, the joints are lapped on a face plate and then ground together. The bolts are pulled up evenly and tight, as the failure to do this will result in an air leak which destroys the air cushion for the piston on the return stroke, with the additional possibility that the piston striking the handle may break the bolts.

When the hammer valve and guide are assembled the valve must be free in its guide. The valve is then inserted in the barrel, care being taken to see that it is free in the barrel as well. The guide is then inserted,

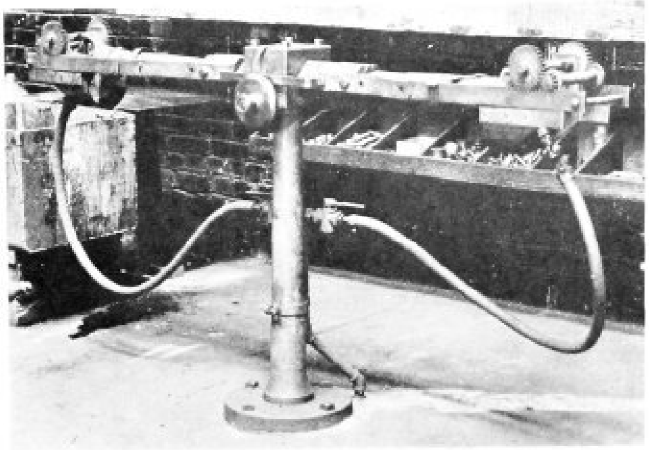


Device for testing the air consumption of pneumatic hammers

and, with the use of a tool known as a guide driver, the guide is driven in until it seats in the bottom. The guide driver consists of a round piece of soft steel about 4 in. long, one end of which is threaded to fit the guide and the other end is plain. As an extra precaution before applying hammer handles the practice is to shake the barrel to make sure the valve is free. On that type of hammer in which the valve box goes inside the barrel the parts are held in a horizontal position in order that the box and the cap will stay assembled when placing them in the barrel. Care is taken to make sure that the exhaust deflector is so located as to discharge the exhaust in the desired direction. Care must also be



Assembly drawing of the pneumatic-hammer testing machine



Test device which compares the force of the blows of repaired hammers with a master hammer

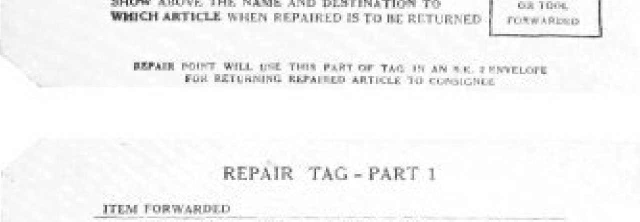
taken to insure that the lug on the deflector is in one of the notches in the barrel so as to prevent it from turning. This is done before applying the handle.

In the case of a one-piece valve box, this is assembled by placing the box on the barrel with the cupped side up and the valve on top of it. In the case of a two-piece valve box the valve seat is placed on the barrel first, then the valve, and finally the valve box with the cupped side down. It is possible on some types to get the seat and the box upside down and, in order to prevent this, a line is cut on the edge of the seat and the box and also on the barrel so that, when assembling, these identification lines all come together.

When assembling hammers equipped with the screw type handle the handle is screwed onto the barrel in such a manner that it will not disturb the valve and the box. This is accomplished by holding the barrel upright until the handle is down in the box. This prevents the valve from getting off its seat and being pinched or possibly broken. The pinch bolt is tightened in order to lock the handle.

When the repairs on pneumatic hammers have been completed they are subjected to a number of tests in order to determine the amount of air they consume, the number of blows per minute they deliver, and the power of the blow delivered. The volume of air consumed by a repaired hammer must not be more than 105 per cent of the manufacturer's rating on a new hammer of that type. The hammer is connected to a device, shown in one of the illustrations, which consists of a block against which the blows of the hammer are directed, and a meter in the air line which indicates the air consumption. Before the hammer is subjected to the tests the workman must make sure that the ports in the valve block and the handle are open. If by chance this should be restricted, the meter will show a low air consumption, which will be a false rating and not indicative of good performance. The next test is that to indicate the number of blows which the hammer delivers per minute. In making this test a hand tachometer, which is placed on the operator's shoulder, indicates the frequency of vibrations as transmitted from the hammer through the operator's arm to the tachometer. Repaired hammers must be able to deliver not less than 95 per cent of the manufacturer's rating for a new hammer of the same type. A testing machine is used to determine the power of the blow delivered by repaired hammers. This is determined by comparison with a master hammer which is known to be in first-class condition. The master hammer is placed in one side of the machine and the hammer to be tested is placed in the other side. The air is first turned on the master hammer, which, during operation, strikes the ram in the machine. The movement of the ram is retarded by a friction block in the center. As the hammer operates the ram travel is indicated in fractions of an inch on a dial on the machine. The time required to move the ram the predetermined distance is noted. This gives the performance of the master hammer, to which that of the repaired hammer is to be compared. The hammer to be tested is then subjected to the same test, the ram in this case traveling in the opposite direction without any change having been made in the fit of the ram in the friction block. The time required to move the ram an identical distance with that made during the test of the master hammer should not be more than 5 per cent greater.

After having been subjected to these tests and passing them satisfactorily, the pneumatic hammers are boxed for shipment. Pitcairn shop, in meeting the requirements for the Central Region, repairs approximately 100 pneumatic hammers of various types each month.

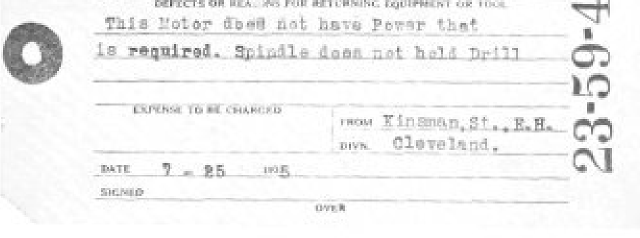


THE PENNSYLVANIA RAILROAD
REPAIR TAG - PART 1
RETURN TO

SHIPPER WILL USE ONE TAG FOR EACH PIECE OF EQUIPMENT OR TOOL FORWARDED

SHOW ABOVE THE NAME AND DESTINATION TO WHICH ARTICLE WHEN REPAIRED IS TO BE RETURNED

REPAIR POINT WILL USE THIS PART OF TAG IN AN S.K. 2 ENVELOPE FOR RETURNING REPAIRED ARTICLE TO CONSIGNEE



REPAIR TAG - PART 1

ITEM FORWARDED

KIND	TYPE	SERIAL NUMBER	CAPACITY
Ing. Rand	C C S B	A 5961	

DEFECTS OR REASONS FOR RETURNING EQUIPMENT OR TOOL
This Motor does not have Power that
is required. Spindle does not hold Drill

EXPENSE TO BE CHARGED
FROM Kinsman, St., E.H.
DIVN. Cleveland.

DATE 7 - 25 195
SIGNED

OVER

23-5-9-46

Front and reverse sides of one of the three parts of the repair tag used for shipping pneumatic tools to the central shop

Crane Builder Using Welded Gears

The Harnischfeger Corporation, Milwaukee, builder of electric overhead traveling cranes, has recently developed a new means of fabricating gears through the use of welding with rolled steel. Lighter weight with greater resistance to wear and strain is claimed. Through this type of construction, all danger of casting flaws is eliminated. In addition, there is the advantage of being able to select special steels for members which are subject to high stresses. Easier replacements are also possible.

Engineering Foundation announces

Welding Research Project

Plans to expand its organization for the advancement of welding research are announced by the Welding Research Committee of the Engineering Foundation, of which Professor Comfort A. Adams of Harvard University is chairman. Under the direction of Colonel C. F. Jenks, commanding officer of the Watertown, Mass., Arsenal, a new industrial subcommittee to coordinate industrial welding research in this country has been formed. Already sixty investigations, guided by a subcommittee on fundamental research, were reported to be under way in universities alone. Many more researches are going forward in industrial and Federal laboratories.

Seven divisional committees are being organized to work with the subcommittee headed by Colonel Jenks in studies of special fields. J. H. Critchett, vice-president of the Union Carbide and Carbon Research Laboratory, New York, has been named chairman of a committee on the welding of low alloy steels. H. C. Jennison, technical manager of The American Brass Company, Waterbury, Conn., will be in charge of a study of copper alloys. J. C. Hodge, chief metallurgist of The Babcock & Wilcox Company, Barberton, O., will direct investigations in carbon steel welding. Four other groups, the members of which are now being selected, will deal with cast iron, high alloy steels, aluminum alloys, and nickel alloys.

Announcement was also made of the formation of three functional subcommittees of the industrial committee. Professor M. F. Sayre of the department of applied mechanics, Union College, has been named chairman of a methods of testing committee; W. D. Halsey, assistant chief engineeer, Boiler Division, Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn., of a committee on the analysis of weld failures; E. Chapman, vice-president of Lukenweld, Inc., Coatesville, Pa., of a committee on weld stresses and their causes and effects. A subcommittee on literature, of which Mr. Critchett is chairman, is at work on a critical digest of the world's welding literature, which it is planned to publish in the interests of American industry. The subcommittee on fundamental research, with H. M. Hobart, consulting engineer of the General Electric Company, as chairman, is fostering welding research in universities.

"Today welding is the most important and most widely used method in industry, and in nearly all of its applications notable savings are effected by superior quality of product," Professor Adams said in a statement explaining the project, which is sponsored jointly by the American Welding Society and the American Institute of Electrical Engineers.

"However, the welding problem is so complicated and the temptation to effect economies is so great that the welding of structures has sometimes been undertaken without a thorough knowledge of the problems involved. Most of the literature of importance is of very recent date, scattered throughout a wide range of publications, and in many languages, with the result that most of it is not available to those actively responsible for the planning and conduct of important welding operations. It is the intent of the Committee on Industrial Research, under the chairmanship of Colonel Jenks, to make a thorough canvass of the investigations under way, contemplated, or needed by industry without interfering in any way with investigations of a confidential nature. The universities will co-operate by conducting worthwhile investigations, other than the sixty already in progress, as may be needed by industry, although specific assignment may, in many cases, be made to industrial and governmental laboratories. Welding and its related methods for cutting metals are undergoing astonishing developments. The variety and flexibility of their applications make them available for use in constructing bridges, frames of buildings, ships, pipe lines, boilers, and other pressure vessels, machines, and many other things, down to small utensils and parts of apparatus and also for repairing and salvaging."

William Spraragen of New York, secretary of the main Welding Research Committee, estimated that not more than 25 percent of the possibilities of welding have been fully explored. Welding and related metal cutting methods can be very useful in repairing the damage done by the recent floods, he pointed out.

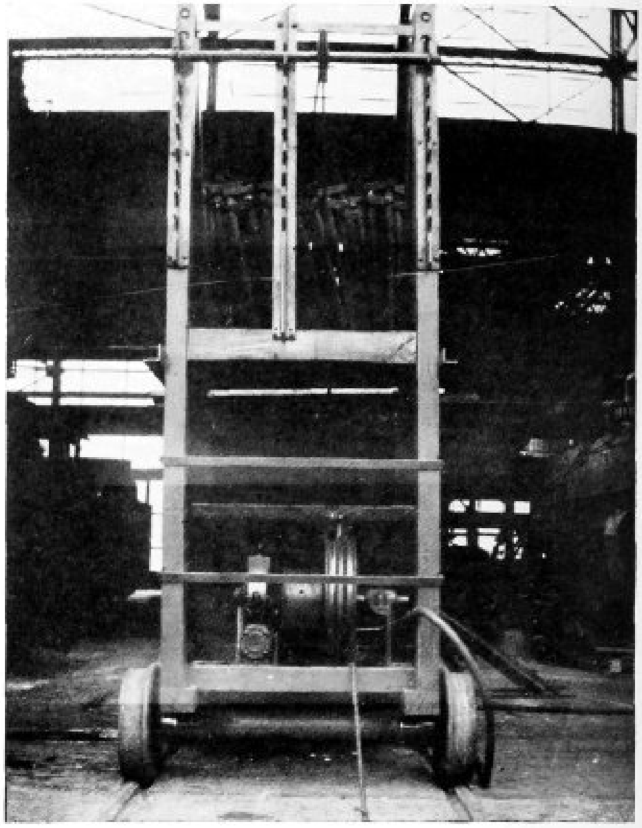
"Gradually the application of welding has been extended to all metals and their alloys, and from thin tubing for aircraft structures to heavy vessels five inches or more in thickness designed to withstand severe service conditions," Mr. Spraragen explained. "Complex problems have resulted, involving the necessity for cooperative action. Welding has made continual and rapid progress in the shipbuilding field. Welded barges are rapidly becoming the standard method of production. There are in existence a number of all-welded ships of the smaller size that have had continuous service for the past fifteen years. Naval treaties have forced all the leading nations of the world to make the maximum use of welding in naval vessel construction in order to save weight. A new era is now well under way in the steel and metal industries, due primarily to the development of high-strength material which results in lighter-weight construction, improved quality, and economies in cost. Welding and cutting have proved important tools in obtaining maximum advantage from this light-weight construction.

"The first applications will of necessity be in places where savings will result, but gradually the use of these superior materials will creep into every form of construction. Engineers and the industries must of necessity keep abreast of the latest developments, and as the reliability of these products are demonstrated, their use will increase."

Germany, according to engineers, was quick to recognize the advantage of welding and by substituting this method for the riveting of plates, has effected large economies in the upbuilding of her navy.

Members of the main Welding Research Committee, in addition to Professor Adams, Colonel Jenks, Mr. Critchett, Mr. Hobart, and Mr. Spraragen are: Frederick T. Llewellyn, research engineer of the United States Steel Corporation; John J. Crowe, engineer-in-charge of apparatus research and development department of Air Reduction Company; David S. Jacobus, advisory engineer of the Babcock & Wilcox Company.

Helpful Devices for Boiler Repairs



Superheater unit puller set in place ready for operation

A number of relatively simple but effective devices for saving labor have been developed at the locomotive shops of the Atchison, Topeka & Santa Fe, Albuquerque, N. M. In general, these devices are neither complicated nor expensive to make, and they are typical of the many ingenious gages, test racks, work-holding fixtures and material-handling devices which railway shop men have developed in recent years to assist them in maintaining production with reduced working time. Among these devices are included several appliances useful in locomotive boiler and superheater repair.

Device for Removing Superheater Units

With the application of Type E superheater units, difficulty is sometimes experienced in removing these units when repairs are necessary to the units, flues or flue sheets, since each of the four loops of each unit is in a separate flue and there is a tendency to jam or bind when the units are being removed. To meet this condition, the superheater unit puller was developed.

The device comprises a ladder-type scaffold and platform, carried on four flanged wheels and having a power unit in the base which consists of a track-wrench motor of a type now obsolete for its original purpose. This motor operates from the shop air line and drives a Foote reduction gear with a ratio of 11½ to 1. A shaft, mounted on the base of the scaffold back of the motor and not shown in the illustration, carries two drums for winding up the rope used in pulling units. The single sliding pulley and shaft at the top of the scaffold are capable of vertical adjustment as required to give a direct pull on the units. A platform provides firm footing, at the proper elevation, for men engaged

Ball bearing cylinder which facilitates removing tubes and flues from locomotive front end in removing the units. A unit-carrying platform, mounted on wheels, is placed between the puller and the locomotive front end.

In operation, the unit puller is blocked the proper distance away from the locomotive front end and a chain placed on three units at once, the puller rope being given a turn or two around the large drum and the air motor started. In most cases this pulls the three units immediately. However, if any difficulty is experienced, the rope is applied around the smaller drum, which decreases the speed and greatly increases the pulling power. The use of this device has reduced the time of unit removal about 75 percent. Two men only are required, one operating the motor and the rope connection and the other hooking on units and properly positioning them on the unit-carrying platform.

Quick Removal of Flues from Boilers

Recent substantially increased flue work at Albuquerque shop has been greatly expedited, at least insofar as handling flues is concerned, by means of the ball-bearing roller shown in one of the illustrations. This device consists of a cylinder made of steel tubing which operates on ball bearings around a shaft of smaller size. Provision is made for shortening or lengthening the bars to fit smokeboxes of different size by means of a telescoping tube construction, with small pins used to hold the telescope sections wherever they may be set. The ball bearings used are old bearings removed from centrifugal feed-water pumps.

The general idea of this device is to provide a free running support for boiler tubes and flues as they are being removed from locomotive front ends. Three men were formerly required for this work, but the use of the ball-bearing roller permits the tubes and flues to readily slide out against the sheet-metal stop on the flue rack and save the work of at least one man.

Work of the A.S.M.E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information on the application of the Code is requested to communicate with the secretary of the committee, 29 West 39th St., New York.

The precedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and published.

Following are records of the interpretations of this committee formulated at the meeting of January 17, 1936, and approved by the Council.

Case No. 815 (*Interpretation of Par. MA-4*)

Inquiry: Does the 95 percent minimum requirement for the reduced-section tension-test specimen in Par. MA-4 apply only in case the failure under test takes place through the weld or through the line of fusion? If it fails outside the weld in the solid plate, must the tensile strength equal the minimum of the specified range of plate used?

Reply: It is the opinion of the committee that in revising Par. U-68*e*, the requirement that the tension test of the joint specimen as specified is intended as a test of the welded joint and not of the plate, was inadvertently omitted in Pars. U-69 and MA-4.

Case No. 816 (Annulled)

Case No. 817

(In the hands of the committee)

Case No. 818 (*Interpretation of Pars. P-301 and H-93*)

Inquiry: Will a valve of the plug-cock type with forced lubrication and fitted with a slow opening mechanism meet the intent of the requirements of Pars. P-301 and H-93?

Reply: It is the opinion of the committee that the intent of the code will be met if a valve of this type is fitted with a slow opening mechanism and with a device which will indicate at a distance whether it is closed or open, and the plug is held in place by a guard or gland.

New Welding Equipment Featured at Power Show

The colorful spectacle of welding flames in action, augmented by the newest developments in equipment and techniques, featured the exhibits of Union Carbide and Carbon Corporation at the Power and Engineering Exposition held in Chicago from April 20 to 24. The Linde Air Products Company demonstrated Lindewelding of pipe and showed their new oxygen and acetylene regulators, cutting machines and acetylene generators. One of the centers of attraction was a live demonstration of Lindewelding pipe which emphasized the speed and perfection of joint which is obtained with the latest apparatus and methods. New Oxweld oxygen and acetylene regulators, shown for the first time, created a great deal of interest. These regulators differed in principle of operation from any that have yet appeared on the market and offered a new departure in appearance. They incorporate many valuable improvements and features which are the result of engineering research.

Lighting Costs Reduced by General Electric

A reduction averaging 20 percent in the list prices of larger-sized Mazda lamps, effective May 1, was announced recently by Gerard Swope, president of the General Electric Company. This constitutes the company's eighteenth major price reduction in lamps since 1921. The types of lamps included in the price change indicate to some extent the changing trends in lighting practices since lamps of 150 watts and more designed for use in kitchens, laundries, stores, offices, factories, schools, and other places, where increased light has been found to increase efficiency and prevent eyestrain, are now in greater demand by the public. The reduction also effects popular types of "indirect three-light" lamps designed for use in the I. E. S. "Better Sight" table and floor units.

Eliminating the Eye Hazard in Industry

The eye hazards of industrial occupations have come to be among the most serious of all causes of blindness. While no extensive authentic statistics are available, it has been repeatedly estimated that at least 15 percent of the blind of America lost their sight because of occupational hazards. Considerable progress has been made in the development of mechanical safeguards for the eyes of factory workers. Some large industrial organizations have brought about marked reductions in the number and severity of eye accidents among their workers. Considering industry as a whole, however, the problem of protecting the eyes of employes is still largely unsolved.

In terms of workmen's compensation, the eye hazards of industry are more serious than any other group of accident hazards, with the single exception of those resulting in death. More money is paid by employers each year as compensation for eye injuries than is paid for injuries to any other part of the body. In the principal industrial states, a total of more than $10,000,000 a year is paid to workmen who have lost all or part of their sight. This, the direct cost, presents only part of the picture.

Analysis of some 75,000 accidents by the Travelers Insurance Company shows that the indirect cost to industry of accidents generally is four times as great as the direct cost, namely, compensation payments and medical fees. When an industrial worker—man or woman—suffers a serious eye injury, a long chain of costly interruption of work ensues; the injured employe's fellow workers lose time in rendering first aid and getting him to a doctor; other workmen lose time watching the proceedings; the foremen and still other men spend time investigating the circumstances of the accident; the general morale of the department, and sometimes of the entire plant, is impaired; often valuable material is destroyed; follow-up investigations consume time. These are only a few of the indirect cost of eye injuries.

It is estimated that these indirect costs—on the basis of actual experiences in the 75,000 instances studied—amount to at least four times the primary cost. It appears then that the actual cost of eye injuries in industry is in the neighborhood of $50,000,000 a year.

That the eye hazards of industry are of the utmost concern to employers, employes and the community as a whole becomes immediately apparent, from an entirely different point of view, when one considers this simple fact; when an arm or a leg is lost as the result of an accident, it can nearly always be replaced by an artificial limb which can do almost anything the human member could do; but when the sight of an eye is destroyed by accident, the loss is irreplaceable—you cannot see a thing through an artificial eye.

The results of twenty years' study of eye injuries by the National Safety Code for the Protection of Heads and Eyes of Industrial Workers, covering nine general groups of processes and operations, are given in this code, as follows:

Group A—Processes where protection from relatively large flying objects is required. Examples: Chipping, calking, and some riveting operations.

Group B—Processes where protection from dust and small flying particles is required. Examples: Scaling and grinding of metals, stone dressing, and some woodworking operations.

Group C—Operations where protection from dust and wind is required. Examples: Automobile driving, locomotive driving and firing, and electric spot and butt welding, where there is no exposure to radiant energy.

Group D—Processes where protection from splashing metal is required. Examples: Babbitting, pouring of lead joints for casting iron pipes, casting of hot metal if there is a possibility that water is present; and dipping in hot metal baths.

Group E—Processes where protection from gases, fumes, and liquids is required. Examples: Handling of acids and caustics, dipping in galvanizing tanks and some japanning operations.

Group F—Processes where protection from an excess amount of dust and small flying particles is required. Examples: Sandblasting.

Group G—Operations where protection is required from reflected light or glare. Examples: Long exposure to snow-covered ground, exposure to reflected sunlight from roofs, roadbeds, etc.

Group H—Processes where protection from injurious radiant energy with a moderate reduction in intensity of the visible radiant energy is required. Examples: Oxy-acetylene and oxy-hydrogen welding and cutting; open-hearth, Bessemer, and crucible steel making; furnace work, electric resistance welding, brazing, and testing of lamps, involving exposure to excessive brightness.

Group I—Processes where protection from injurious radiant energy with a large reduction of the visible radiant energy is required. Examples: Electric arc-welding and cutting.

How Hazards Can Be Eliminated

How can these hazards be eliminated or their effects counteracted? Briefly, they can be prevented in three ways: (1) by the provision of protective equipment, such as goggles and head masks for individual workmen, screens of metal, wood or canvas between workmen, and glass shields or other approved protective devices at the point of operation of emery wheels and other machines, operation of which is attended by flying particles, or splashing of molten metal, or injurious chemicals; (2) by revision of the process of work, by redesign of tools and machines, by rearrangement of machines and other plant equipment; and (3) by rules of work, by supervision, training and education in safe practices of workmen and foremen.

In the last connection, too much emphasis cannot be placed on two facts: (1) that mandatory rules concerning the use of goggles and other protective devices in particular operations and the strict enforcement of these rules are proving the most effective means of reducing eye injuries; and (2) that it is worse than futile to establish mandatory or other stringent rules in plants where they cannot be enforced or where they are not supplemented by year-round educational activities and supervision that is not only sympathetic to organized accident prevention, but sincerely enthusiastic about it.

Proposed Revisions and Addenda to the A.S.M.E. Boiler Construction Code

It is the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the rules and its codes. Any suggestions for revisions or modifications that are approved by the committee will be recommended for addenda to the code, to be included later in the proper place in the code.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticism and approval from any one interested therein. It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the council of the society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the committee for consideration.

PAR. P-282. Insert the following after the second sentence:

"The lifting lever shall be such that it cannot lock or hold the valve disk in lifted position when the exterior lifting force is released."

PAR. P-301. Revise second sentence to read:

"When such outlets are over 2-in. pipe size, the valve or valves used on the connection shall be of the outside-screw-and-yoke rising-spindle type OR OF SUCH OTHER TYPE as to indicate AT A DISTANCE by the position of its spindle OR OTHER OPERATING MECHANISM whether it is closed or open, and the wheel may be carried either on the yoke or attached to the spindle. IF THE VALVE IS OF THE PLUG COCK TYPE IT MUST BE FITTED WITH A SLOW-OPENING MECHANISM (SEE PAR. P-311) AND AN INDICATING DEVICE, AND THE PLUG MUST BE HELD IN PLACE BY A GUARD OR GLAND."

PAR. P-314. Add the following sentence:

"When the boiler is under pressure feedwater shall not be introduced through the openings or connections used for the water column, the water-gage glass, or the gage cocks. In closed systems the water may be introduced through any opening when the boiler is not under pressure."

PAR. A-19. Revised:

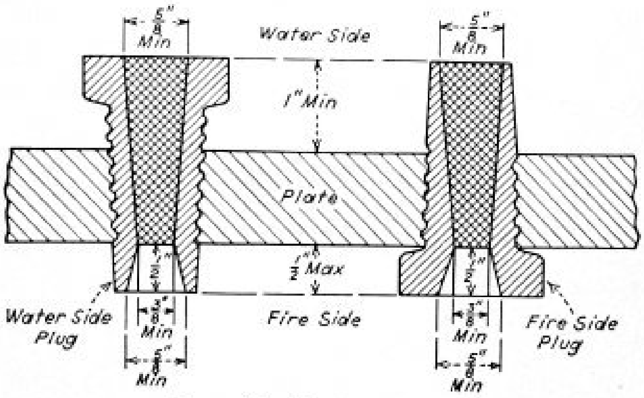
A-19. *A* Fire-actuated fusible plugs, if used, shall be filled FROM THE WATER SIDE AND TO THE POINT OF LEAST DIAMETER OF THE WHOLE IN THE CASING with tin OF THE FOLLOWING COMPOSITION, having a melting point between 400 and 500 F:

PURE TIN, MINIMUM, PERCENT	99.3
COPPER, MAXIMUM, PERCENT	0.5
LEAD, MAXIMUM, PERCENT	0.1
TOTAL IMPURITIES, PERCENT	0.7

B THE FILLING SHALL BE CAREFULLY ALLOYED WITH THE CASING.

C THE FUSIBLE PLUGS [and] shall be renewed AT LEAST once each year.

D When the boilers are [to be] operated at working pressures in excess of 250 [225] lb. per sq. in., the use of fusible plugs is not advisable.



Proposed fusible plug dimensions

PAR. A-20. Revised:

A-20. *A* WATER-SIDE PLUGS ARE FUSIBLE PLUGS WHICH ARE INSERTED FROM THE WATER SIDE OF THE PLATE, FLUES OR TUBES TO WHICH THEY ARE ATTACHED. FIRE-SIDE PLUGS ARE FUSIBLE PLUGS INSERTED FROM THE FIRE SIDE OF THE PLATE, FLUE, OR TUBE TO WHICH THEY ARE ATTACHED.

B THE CASING OF FUSIBLE PLUGS SHALL BE MADE OF BRONZE OF THE FOLLOWING COMPOSITION:

COPPER, MINIMUM, PERCENT	86.0
TIN AND ZINC COMBINED,[1] MINIMUM, PERCENT	10.0
LEAD, MAXIMUM, PERCENT	0.3

[1] ZINC AND LEAD MAY BE REPRODUCED OR ELIMINATED IF REPLACED BY COPPER AND TIN.

C THE DESIGN OF CASINGS SHALL BE IN ACCORDANCE WITH FIG. A-10.

D THE BORE OF THE CASING SHALL BE TAPERED CONTINUOUSLY AND EVENLY FROM THE WATER END OF THE PLUG TO A DIAMETER OF NOT LESS THAN 3/8 IN. AT A POINT 1/2 IN. FROM THE FIRE END. THE DIAMETER OF THE BORE AT EITHER END OF THE PLUG SHALL NOT BE LESS THAN 5/8 IN.

E A FUSIBLE PLUG SHALL BE OF SUCH LENGTH THAT WHEN INSTALLED, IT SHALL PROJECT AT LEAST 1 IN. ON THE WATER SIDE OF THE PLATE, TUBE OR FLUE AND AS LITTLE AS POSSIBLE BUT NOT MORE THAN 1/2 IN. ON THE FIRE SIDE. If a fire-actuated fusible plug is inserted in a tube, the tube-wall shall be not less than 0.22 in. in thickness or sufficient to give four full threads.

[The least diameter of fusible metal in a fire-actuated plug shall be not less than 1/2 in., except for maximum allowable working-pressures of over 175 lb. per sq. in., or when it is necessary to place a fire-actuated fusible plug in a tube, in which case the least diameter of fusible metal shall be not less than 3/8 in. (See Fig. A-10).]

TABLE A-10. Add the following:

Pressures given in American Standards for 750 F					
100	300	400	600	900	1500
Maximum pressures at which boilers can be operated when using the above standard flanged fittings for feed and blow-off service under Pars. P-299 and P-310.					
...	318	416	605	878	1395

PARS. H-38 AND H-91. Add the following sentence: "Feedwater shall not be introduced through the openings or connections used for the water column, the water-gage glass, or the gage cocks."

PAR. H-93. Revise fifth section to read:

"When stop valves over 2 in. in size are used, they shall be of the outside-screw-and-yoke RISING-SPINDLE type OR OF SUCH TYPE AS TO INDICATE AT A DISTANCE BY THE POSITION OF ITS SPINDLE OR OTHER OPERATING MECHANISM WHETHER IT IS CLOSED OR OPEN, AND THE WHEEL MAY BE CARRIED EITHER ON THE YOKE OR ATTACHED TO THE SPINDLE. IF THE VALVE IS OF THE PLUG COCK TYPE IT MUST BE FITTED WITH A SLOW-OPENING MECHANISM AND AN INDICATING DEVICE, AND THE PLUG MUST BE HELD IN PLACE BY A GUARD OR GLAND."

PAR. M-13. Add the following sentence:

"When the boiler is under pressure feedwater shall not be introduced through the openings or connections used for the water column, the water-gage glass, or the gage cocks. In closed systems the water may be introduced through any opening when the boiler is not under pressure."

PAR. MA-3. Revise the first two sections to read:

Test Specimens. [Two full-section tension-test specimens] Two reduced-section tension-test specimens, two nick-break-test specimens and two bend-test specimens shall be required from each test plate.

[*Full-Section Tension-Test Specimen.* The shape and dimensions of the tension-test specimen shall be as shown in Fig. MA-2, with the weld at the center. Data shall be recorded on the ultimate strength and computed from the area of the base-metal section (pounds per square inch).]

PAR. MA-4. Revise second section to read:

Tension Tests. [Each full-section tension specimen should fail in the plate if the weld reinforcement is retained, but if failure occurs in the weld metal or along the line of fusion between the weld metal and the plate, then the tensile strength shall not be less than the minimum of the specified tensile range of the plate used.] For the reduced-section tension-test specimens the tensile strength shall not be less than 95 percent of the minimum of the specified tensile range of the plate used. (THE TENSION TEST OF THE JOINT SPECIMEN AS SPECIFIED HEREIN IS INTENDED AS A TEST OF THE WELDED JOINT AND NOT OF THE PLATE.)

FIG. MA-1. Omit reference to full-section tension-test specimen.

FIG. MA-2. Omit.

PAR. U-69*c*. Omit second section which reads:

[*Full-Section Tension-Test Specimen.* The shape and dimensions of the tension test specimen shall be as shown in Fig. U-14, with the weld at the center. Data shall be recorded on the ultimate strength and computed from the area of the base metal section (pounds per square inch).]

PAR. U-69*d*. Revise second section to read:

Tension Tests. [Each full-section tension specimen should fail in the plate if the weld reinforcement is retained, but if failure occurs in the weld metal or along the line of fusion between the weld metal and the plate, then the tensile strength shall not be less than the minimum of the specified tensile range of the plate used.] For the reduced-section tension-test specimens the tensile strength shall not be less than 95 percent of the minimum of the specified tensile range of the plate used. (THE TENSION TEST OF THE JOINT SPECIMEN AS SPECIFIED HEREIN IS INTENDED AS A TEST OF THE WELDED JOINT AND NOT OF THE PLATE.)

PAR. U-70*c*. Revise first two sections to read:

c Test Specimens. [Two full-section tension-test specimens] Two reduced-section tension-test specimens and two bend-test specimens shall be required from each test plate.

[*Full-Section Tension-Test Specimen.* The shape and dimensions of the tension-test specimen shall be as shown in Fig. U-14 with the weld at the center. Data shall be recorded on the ultimate strength and computed from the area of the base-metal section (pounds per square inch).]

PAR. U-70*d*. Revise second section to read:

"*Tension Tests.* [Each full-section tension specimen should fail in the plate if the weld reinforcement is retained, but if failure occurs in the weld metal or along the line of fusion between the weld metal and the plate, then the tensile strength shall not be less than 90 percent of the minimum of the specified tensile range of the plate used.] For the reduced-section tension-test specimen the tensile strength shall not be less than 85 percent of the minimum of the specified tensile range of the plate used. In no case shall the tensile strength be less than 42,000 lb. per sq. in. (THE TENSION TEST OF THE JOINT SPECIMEN AS SPECIFIED HEREIN IS INTENDED AS A TEST OF THE WELDED JOINT AND NOT OF THE PLATE.)

FIG. U-13. Omit reference to full-section tension-test specimen.

FIG. U-14. Omit.

Republic Steel Announces Metallurgical Appointment

Earl C. Smith, chief metallurgist of Republic Steel Corporation, has announced the appointment of Muir L. Frey to the metallurgical staff with headquarters at the Republic plant in Buffalo. Mr. Frey comes to Republic from John Deere Tractor Company, Waterloo, Ia., where he has held the position of chief metallurgist for the past ten years. During this time he was active in the improvement of the metallurgical and mechanical technique in the manufacture of transmission gears for the tractor industry.

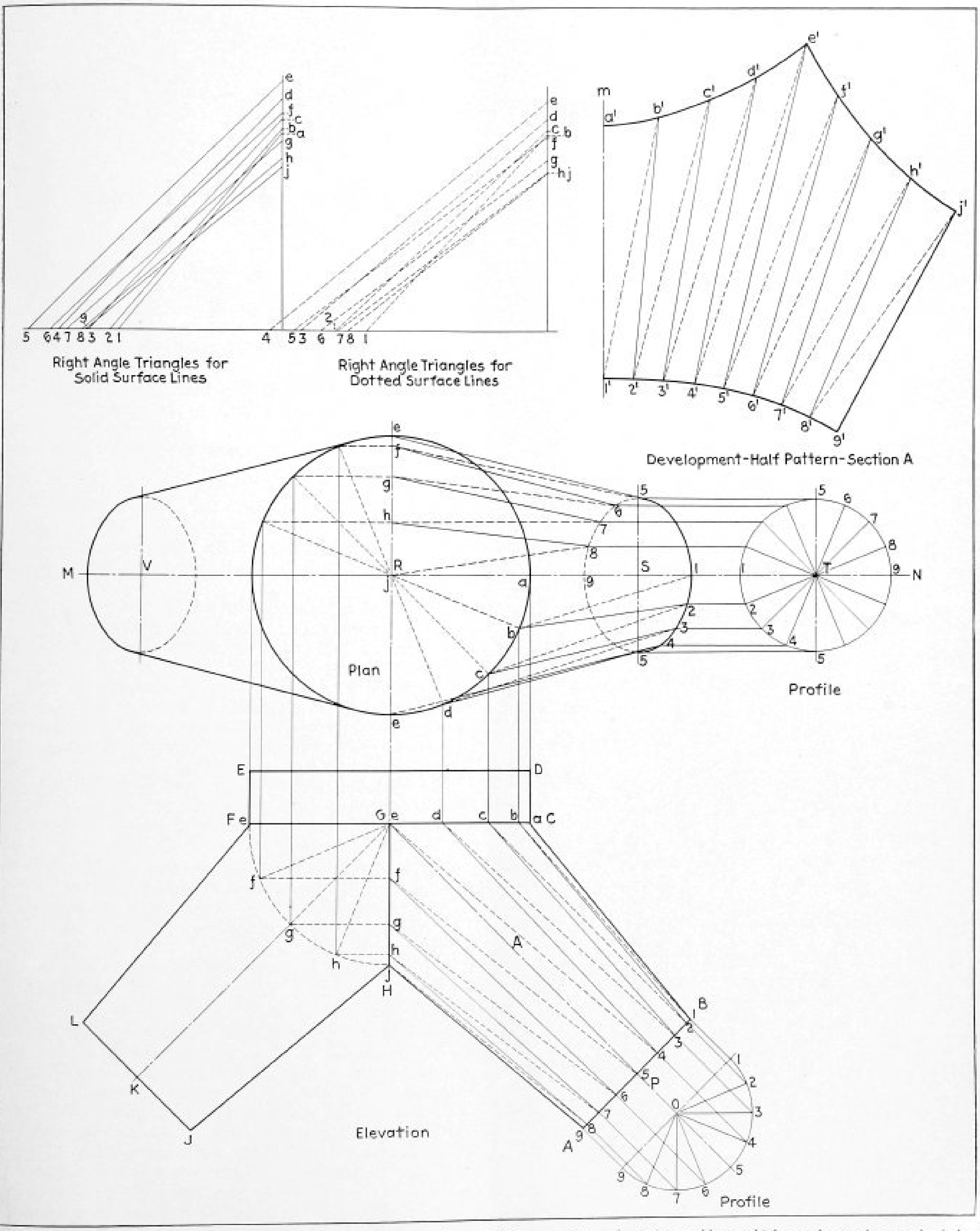
He was born in 1900 at Bunker Hill, Ill., and received his technical education at the University of Missouri School of Mines and Metallurgy from which he was graduated in 1923 with the degrees of B. S. and M. S. in metallurgy. Mr. Frey received his primary experience with the U. S. Bureau of Mines as a junior metallurgist and was later associated with the Caterpillar Tractor Company and Gerlinger Electric Steel Casting Company before joining John Deere Tractor Company.

E. R. Norris Retires from Westinghouse

E. R. Norris, who is well known to the machine tool industry, retired April 1, after 44 years continuous service with the Westinghouse Electric & Manufacturing Company in the manufacturing and equipment phase of the business. At the time of his retirement Mr. Norris held the position of assistant to the general works manager. Having acquired a vast experience in manufacturing operations in his early years with the company, he was transferred to the staff of the manager of works in 1904. Subsequently, he was appointed assistant works manager and director of works equipment. A recognized authority on factory costs and manufacturing equipment, he was appointed general works manager in 1928 and two years later became assistant to the vice president.

Problem No. 9—Correct Layout

Y-Pipe Connection



Problem No. 9 was published on page 67 of the March issue. Above is the correct layout of this problem, which can be used as a check by readers who have attempted to solve this problem

PRACTICAL PLATE DEVELOPMENT — XIII

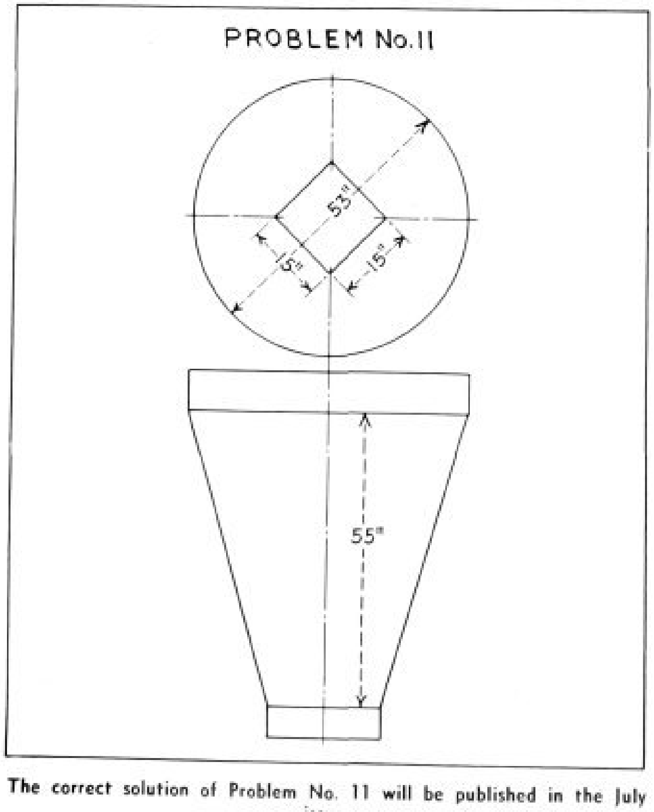
Irregular-Shaped Hopper

By George M. Davies

The irregular-shaped hopper to be considered is illustrated in Figs. 115 and 116. The hopper has a circular bottom with an irregular-shaped top. In developing an irregular-shaped object the first consideration should be the manner in which the plate is to be fabricated. As the hopper has a circular bottom with flat sides, the corners will of necessity be conical shape. As the front and back of the top also form arcs of a circle with tangent sides, the center portion can also be rolled to a conical shape. The object thus becomes a series of conical sections and flat sides and the radial line method of development can best be used.

An examination of the plan view will show that the center line *R-S* divides the hopper into two symmetrical halves, therefore a development of one half of the plan is all that will be necessary, a duplicate of the pattern obtained completing the whole pattern.

Problem No. 11 for Readers to Lay Out



The correct solution of Problem No. 11 will be published in the July issue

The first step in the development is to divide the semicircle *T-U*, Fig. 116, into any number of equal parts. Ten are taken in this case, although the greater the number of equal parts taken the more accurate will be the final development. Number these divisions from 1 to 11 as shown. Parallel to the center line *M-N* draw lines through the points 1 to 11, extending same down into the elevation cutting the line *E-F*. Number these points from 1 to 11, as shown.

Connect the points 1-6 in the plan, Fig. 116, with the point *K* and points 6-11 with the point *L*. In the elevation connect the points 1-6 with the point *B* and the points 6-11 with the point *C*. The lines will be the surface lines of the conical corners in the plan and elevation.

Next erect a perpendicular to the line *L-W* passing through the point *U*, Fig. 116, locating the point *W*. Also erect a perpendicular to the line *K-X* passing through the point *T* locating the point *X*.

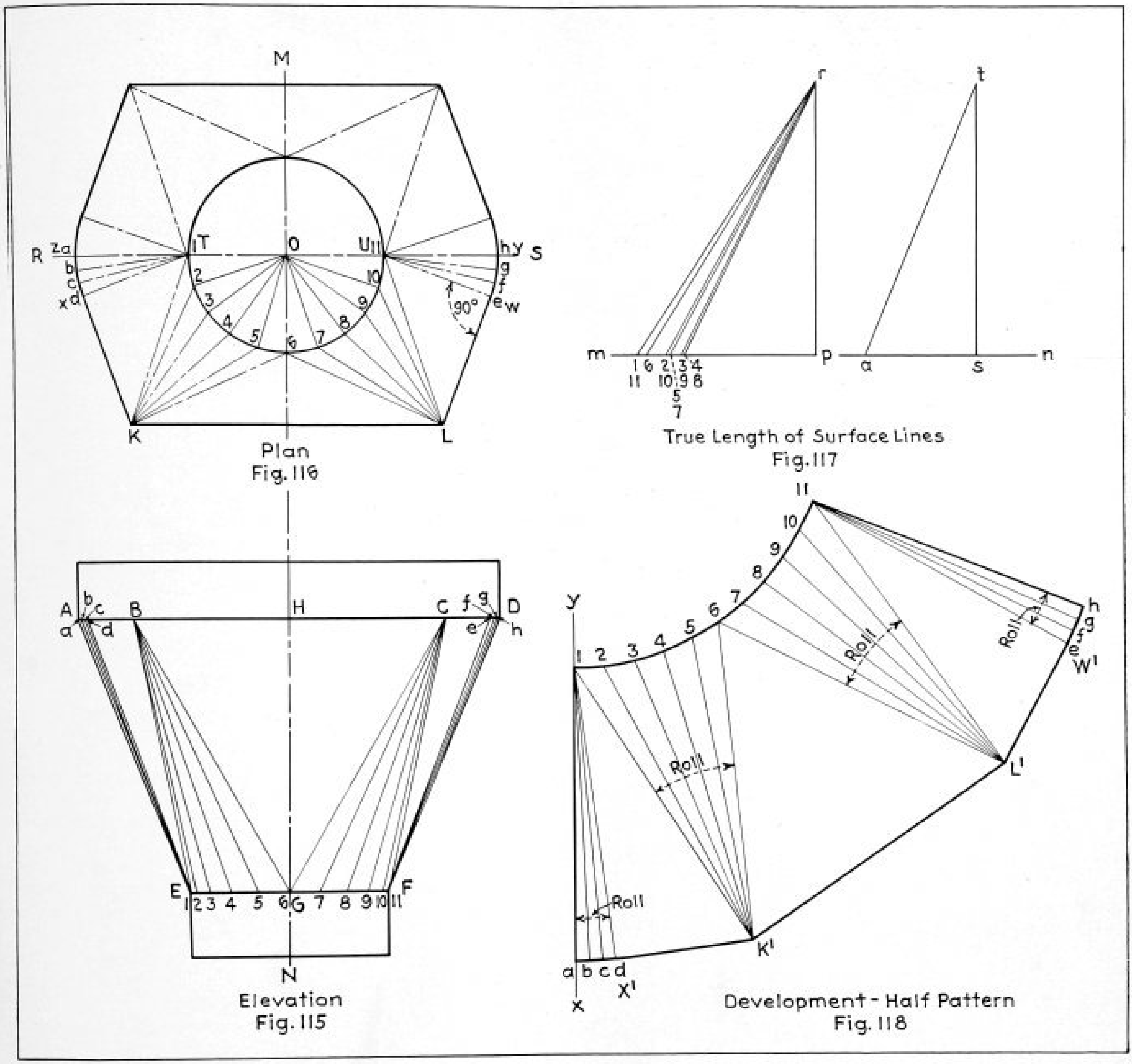
Divide the arcs *Z-X* and *W-Y* into any number of equal parts. Four are taken in this case, although the greater the number of parts taken the more accurate the final development will be. Number the points from *a* to *d* and from *e* to *h* as shown.

Then parallel to *M-N* draw lines through the points *a* to *h*, extending same down into the elevation, cutting the line *A-D*. Number these intersections in the elevation from *a* to *h* as shown.

In the plan connect the points *a* to *d* with *T*, and *e* to *h* with *U*. In the elevation connect the points *a* to *d* with *E*, and *e* to *h* with *F*. These lines will be the surface lines of the conical portion of the front and back of the hopper.

The next step is to obtain the true lengths of the surface lines of the conical portions of the hopper.

Draw any line as *m-n*, Fig. 117, and at *p* erect a perpendicular. On this perpendicular step off the distance *p-r* equal to *G-H* of the elevation. Then on the line *m-n* from *p* step off the distance *p*-1 equal to the distance *K*-1 of the plan. Connect the points 1-*r*, Fig. 117, with a line, which will be the true length of the surface line *K*-1 in the plan. In like manner step off the distances *p*-2, *p*-3, *p*-4 to *p*-6 equal to *K*-2, *K*-3, *K*-4 to *K*-6, Fig. 116, and the distances *p*-7, *p*-8, *p*-9 to *p*-11 equal to *L*-7, *L*-8, *L*-11, Fig. 116. Connect the points 2 to 11, Fig. 117, to the point *r*, these lines being the true length of the corresponding surface lines in the plan, Fig. 116.



Layout of pattern for irregular hopper

Then on *m-n* erect a perpendicular at *s*. Step off on this perpendicular the distance *s-t* equal to *G-H* of the elevation. From *s* on the line *m-n* step off the distance *s-a* equal to *T-a*, Fig. 116. Connect the points *a* and *t*, Fig. 117, with a line, this line being the true length of the surface line *T-a* of the plan, the points *b*, *c* and *d* being radial around *T* and the points *e* to *h* being radial around U. The length of these surface lines will be the same as that for *T-a*, thus completing the true lengths for all the surface lines of the conical portions of the object.

Constructing the Pattern

Draw any line as *x-y*, Fig. 118, and step off the distances *a-1* equal to *A-E* of the elevation or *a-t*, Fig. 117.

Then with 1 as a center and with the trams set equal to *a-t*, Fig. 117, scribe an arc.

Step off on this arc the distances *a-b*, *b-c*, *c-d* equal to *a-b*, *b-c*, *c-d*, Fig. 116. Connect the points 1-*d*, Fig. 118.

Then with *d* as a center and with the trams set equal to *X-K* of the plan, scribe an arc. With 1 as a center and with the trams set equal to 1-*r*, Fig. 117, scribe an arc cutting the arc just drawn, locating the point *K'*.

With 1 as a center and with the dividers set equal to the distance 1-2 of the plan, Fig. 116, scribe an arc. Then with *K'* as a center and with the trams set equal to 2-*r*, Fig. 117, scribe an arc cutting the arc just drawn, locating the point 2, Fig. 118.

Continue in this manner, making the distances 2-3, 3-4, 4-5, 5-6 equal to the distances 2-3, 3-4, 4-5, 5-6 of the plan, Fig. 116, and the distances *K'*-3, *K'*-4, *K'*-5, *K'*-6 equal to the distances 3-*r*, 4-*r*, 5-*r*, 6-*r*, Fig. 117.

Then with *K'* as a center and with the trams set equal to the distance *K-L* of the plan, scribe an arc, then with 6 as a center and with the trams set equal to 6-*r*, Fig. 117, scribe an arc cutting the arc just drawn, locating the point *L'*.

Continue as before, making the distances 6-7, 7-8, 8-9, 9-10, 10-11 equal to their corresponding distances in the plan, and the distances L'-7, L'-8, L'-9, L'-10, L'-11 equal to 7-*r*, 8-*r*, 9-*r*, 10-*r*, 11-*r*, Fig. 117, completing the pattern to L'-11.

Then with L' as a center and with the trams set equal to *L-W* of the plan, scribe an arc, and with the point 11 as a center and with the trams set equal to *a-t*, Fig. 117, scribe an arc cutting the arc just drawn, locating the point *e*. Step off on the arc just drawn the distances *e-f*, *f-g* and *g-h* equal to *e-f*, *f-g* and *g-h* of the plan, completing the half pattern. To complete a full pattern make a duplicate of this pattern and add same along the line 11-*h*.

The pattern as shown is taken on the neutral axis of the plate and no allowances have been made for seams, which must be added in the actual layout when the hopper is built.

Motor Truck Equipped with Arc Welding Set

Job welders, pipe line contractors, steel erectors, repair shops and other arc welding users to whom portable welding equipment is a necessity, can now install an arc-welding generator on any standard 1½-ton truck and drive the welder direct from the truck motor. This is made possible by a power take-off developed by The Hercules Steel Products Company, Galion, O., in conjunction with The Lincoln Electric Company, Cleveland.

Motor truck fitted with power take-off driving arc-welding generator

This power take-off, which makes a truck a power plant as well as a means of transportation, is made in various models to operate as a direct drive or from the side. The unit is adaptable to all makes and models of trucks. It does not affect the road speed or power of the truck, since it simply replaces a portion of the truck's drive shaft.

Power supplied by any leading make of 1½-ton truck is sufficient to drive either a 200-ampere or a 300-ampere welding generator. Power take-off can be controlled from the driver's seat by a single lever. While welding, the speed of the truck motor is controlled by a fly-ball type mechanical governor. Made of chrome-nickel alloy steel, this power take-off weighs 100 pounds fully installed. All bearings are anti-friction ball and roller type. The unit is guaranteed to transmit 120 brake horsepower at 2800 revolutions per minute, 220 foot-pounds torque.

Welded Pipeline Laid in West

Plans have just been completed for laying a new main trunk natural gas line from Carlsbad to Escondido, Cal. The line will be constructed by the owner, the San Diego Gas and Electric Company and will be completely welded. The total length of this new line will be about fifteen miles. It will require 58,000 feet of 2½-inch and 21,000 feet of 3-inch standard pipe. The line will be designed to carry natural gas at a peak pressure of 400 pounds per square inch. Work is to start May 15.

Novel Nickel Exhibit at Foundry Exposition

A novel treatment in exhibit background construction was employed by The International Nickel Company, Inc., in its booth at the Foundry and Allied Industries Exposition held in Detroit May 5 to 9. The treatment adopted made use of a background composed almost entirely of sheets of electrolytic nickel, the basic product used in the production of ferrous and non-ferrous nickel alloys. Electrolytic nickel is the purest form of nickel commercially available. A typical analysis puts the nickel content at 99.95 percent.

New Developments Made in Portable Cable Connectors

Increased use of portable electric equipment has brought a widespread demand for satisfactory methods of connecting and terminating portable cable. In recognition of this need the General Electric Company, Schenectady, N. Y., has announced a line of portable cable accessories which includes high-voltage cable couplers and molded terminals for all voltages. These new cable products are designed to incorporate safety, long wear, and convenience in the field.

For use on high-voltage cable applications, a newly designed coupler is offered which is rated at 100 amperes, and is particularly adapted for use with G-E 2500-, 3500-, and 5000-volt, types SH and G, portable cables. Provision is made in the coupler socket so that the shielding tapes or ground conductors of the cable can be brought out for grounding purposes. The coupler socket and plug are made of a malleable-iron frame with a malleable-iron end bell, which is bolted on. The current-carrying contacts are the sliding-spring type and are enclosed and shielded by Herkolite tubing. There are four contacts, three of which are for the individual conductors of a three-conductor cable; the fourth contact is for the shielding braid or ground wires. That the coupler may be used as a connector between cable lengths, the end bells have been made interchangeable so that the plug-end bell may be put on the socket end in place of the socket-end bell and flexible connections made at each end of the coupler.

The recently developed molded-rubber terminal is expected to be adaptable in cases where it is desirable to terminate portable or drag cable at the source of energy or at the load by means of a terminal which will hold the single conductors firmly together as a unit. The terminal is made of G-E R-387 tellurium compound and provides means of properly terminating ground wires and braided shields so that they can be correctly grounded. The additional cost of applying terminals is very slight.

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

VOLUME XXXVI NUMBER 5

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BUSINESS MANAGER: Warner Lumbard.

Contents

Toncan Topics.—The Republic Steel Corporation, Cleveland, in its latest edition of Toncan Topics, describes the application of Toncan iron sheets and pipes to recent building enterprises at the University of Virginia, a school structure, a hotel and a large western cement plant.

Nickel Alloys.—The spring edition of the quarterly magazine entitled "Inco," published by the International Nickel Company, New York, in the interests of nickel and nickel alloys contains articles on a large sewage disposal system, a unique roofing problem and various other subjects in which some use is made of nickel or its alloys.

Integral-Furnace Boilers.—A fully illustrated 24-page booklet containing details of the design and construction of the integral-furnace boiler has been recently published by the Babcock and Wilcox Company, New York. Also included in this booklet are typical performance data and photographs and diagrams of structural details and installation of a number of these boilers.

Oxy-Acetylene Welding.—The Linde Air Products Company, a unit of Union Carbide and Carbon Corporation, New York, in their May number of Oxy-Acetylene Tips include descriptive matter on interesting applications of oxy-acetylene torches for cutting intricate plate shapes, rebuilding of worn parts, pipe welding and numerous small articles on interesting phases of welding.

Control Instruments.—In order to bring out the advantages in operating efficiency, fuel economy and lessened repair costs by the use of proper recording instruments for boilers, industrial processes and other uses, the Brown Instrument Company, Philadelphia, recently issued a bulletin describing the application of their complete line of controllers, CO_2 meters, flow meters, gages, hygrometers, thermometers, tachometers, etc., in the industrial world.

Electric Welding.—A Handbook of Electric Weld Tubing, containing a considerable amount of up-to-date information and giving the user a thorough knowledge of the application of welded steel tubing, its physical, chemical and metallurgical properties, commercial tolerance limitation and extensive data, has been published by Steel and Tubes, Inc., a subsidiary of Republic Steel Corporation, Cleveland.

Nickel Alloy Gears.—A recent publication entitled "Nickel Alloy Gear Materials and Their Heat Treatment" by J. W. Sands and F. J. Walls, has recently been published by the International Nickel Company, Inc., New York. The publication deals with the correct selection of gear materials for specific purposes, and tables and charts are given of the physical properties of various nickel alloys and recommendations as to the most suitable type to be used under various industrial services.

Baldwin Locomotives.—The spring number of the quarterly magazine published by the Baldwin Locomotive Works, Philadelphia, entitled "Baldwin Locomotive," contains articles on the economics of locomotive operation, the centennial celebration of the Central of Georgia Railway, the Mikado type of locomotives, a discussion on the single expansion articulated locomotive, hydraulic presses and a continued feature article on locomotive weight distribution.

Aftercoolers.—The Ingersoll Rand Company, New York, manufacturer of various engines and compressors and their accessories, has now available a small bulletin featuring an aftercooler of new design recently developed by the company. This aftercooler is designed for air and gas compressors of moderate capacities and is for use in the discharge line in place of the section of the pipe.

Mortars and Plastics.—The Babcock and Wilcox Company, New York, has published recently an eight-page booklet, fully illustrated, presenting the general characteristics as well as the specific properties of each of the five B & W mortars and plastics manufactured by them for installation in their own boilers and others. In order to simplify the selection of the correct mortar or plastic for each type of work, a reference table is provided that contains vitrification, melting and use-limit temperatures, together with the weight or volume required for application, as well as the size of containers available.

Questions and Answers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Countersunk Rivet

Q.—Will you kindly tell me how to determine the depth and the width and the angle that is best in countersinking a hole in 5/8-inch boiler plate for driving a flat 7/8-inch rivet? J. K., Jr.

A.—The size of the counterbore in the plate for flat countersunk rivets will vary more or less in the different

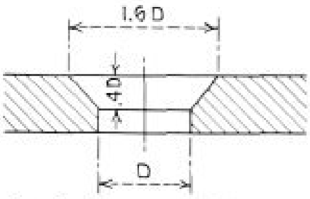

Fig. 1.—Countersunk hole

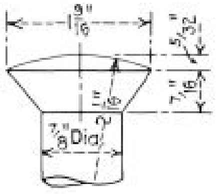

Fig. 2.—Rivet head

shops. The dimensions shown in Fig. 1 represent average conditions. A practical application is shown in Figs.

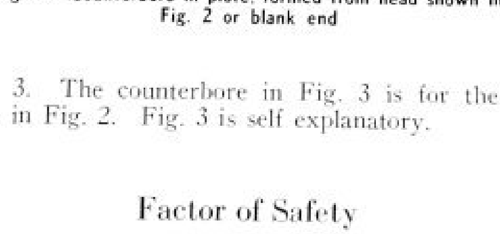

Fig. 3.—Counterbore in plate, formed from head shown in Fig. 2 or blank end

2 and 3. The counterbore in Fig. 3 is for the rivet shown in Fig. 2. Fig. 3 is self explanatory.

Factor of Safety

Q.—Would you be so kind as to explain how to arrive at the factor of safety? For locomotive boilers it is 4. What I want to know is how to arrive at that 4. J. G. G.

A.—The term factor of safety is defined as the ratio of the ultimate strength of material or structure to the allowable stress.

In boiler work the term factor of safety can be taken as the ratio of the bursting pressure to the working pressure, thus:

$$\text{Factor of safety} = \frac{\text{Bursting pressure}}{\text{Working pressure}}$$

All locomotive boilers operating in the United States must have a factor of safety of 4 to comply with the locomotive inspection law.

This law states:

Rule 2—The lowest factor of safety for locomotive boilers, which were in service or under construction prior to January 1, 1912, shall be 3.25.

Effective October 1, 1919, the lowest factor shall be 3.5.

Effective January 1, 1921, the lowest factor shall be 3.75.

Effective January 1, 1923, the lowest factor shall be 4.

The factor of safety of 4 is an arbitrary margin of safety set by law to protect against

1. Deterioration due to corrosion,
2. Errors in workmanship,
3. The interdependence of parts,
4. The probability of overload,
5. Stresses due to method of suspension, and
6. Lack of homogeneity in the material.

The factor of safety computed by the following formula must not be less than 4 in order to comply with the locomotive inspection law

$$FS = \frac{TS \times t \times E}{R \times WP}$$

where,

T = ultimate tensile strength stamped on shell plates, pounds per square inch.

t = minimum thickness of shell plates in weakest course, inches.

E = efficiency of longitudinal joint or ligaments between tube holes (whichever is the least).

R = inside radius of the weakest course of the shell, inches.

WP = allowable working pressure, pounds per square inch.

FS = Factor of safety.

Safe-Ending of Boiler Tubes by Oxy-Acetylene and Electric Arc Welding Methods

Q.—As a subscriber to your magazine, I would appreciate it if you will advise me what procedure is being used for safe-ending boiler tubes by the oxy-acetylene and the electric arc welding methods. We have been safe-ending tubes by the forge method, but, as the New York Code now permits fusion welding, we think it would be cheaper, and therefore would like to know what others are doing about this. G. R. G.

A.—The New York State Industrial Code Bulletin No. 14 Rules, as amended relating to the construction, installation, inspection and maintenance of steam boilers, provides for safe ending of boiler tubes by the oxy-acetylene and the electric-arc welding as follows:

Rule 14-8

Repairs by Fusion Welding:

Only welders who have demonstrated their fitness to produce sound welds, the results of which would meet the requirements of standard welding codes, should be employed.

Rule 14-8.2

Repairs by welding shall not be made until an inspection has been made by an inspector. The method of repairs shall be in accordance with these rules and shall be approved by him. If, in the opinion of the inspector, a hydrostatic test is necessary, such test shall be applied when work is completed.

Rule 14-8.4

The use of bare welding wire is prohibited in making repairs by electric welding.

Rule 14-8.12

When tubes on firetube boilers are re-ended or pieced, there shall not be more than two circumferential welds in each tube. Such re-ending or piecing shall be done by one of the following methods.

(a) By the electric-resistance butt welding method.

(b) By the metallic-arc method.

(c) By the oxy-acetylene process.

Specification—Tubes

Specifications for lap-welded and seamless steel and lap-welded iron boiler tubes S-17.

The two methods of safe-ending tubes most commonly used are as follows:

(1) The following procedure outlines in a general way the process of safe-ending boiler tubes by the electric-resistance butt-welding method:

With this method the tubes are first cleaned in a rattler to remove all scale and dirt, either a dry or wet rattler can be used, the best argument in favor of the submerged wet rattler is that it is dustless and almost noiseless. The tubes and safe ends are then cut off either square or beveled as desired. When cut off square the tubes are butt-welded together giving the greatest amount of solid surface in contact. When beveled, the tube is scarfed and the safe end beveled, both to the same degree, thus forming a lap to guard against the tube falling into the boiler, if the weld should be defective or overheated. All burrs should be removed after cutting the tubes.

The next step is to clean the tubes and safe ends where the welding electrodes are to be clamped on. This is done to obtain a good contact with the tube and with the safe end, so as to prevent the tubes from heating at these points instead of at the junction of the tube and the safe end when being welded in the welding machine.

The general principle of the welding machine is that the heat is induced by passing a large volume of electrical current of low voltage through the butting tube and safe end to be welded, the heating effect being caused by the resistance of the metal to the flow of the current. The greatest resistance to the flow of current is between the butting ends which therefore become hot first. When they reach the proper welding temperature, the current is turned off and pressure applied mechanically to force the molten ends together, thereby producing a weld. This operation takes about 45 seconds.

The most important part in welding safe ends on flues is the careful observation of the heat. Steel will fuse at about 2450 degrees F. and will make a very sound weld at about 2600 to 2800 degrees F., at which point the metal is much softer. At about 3000 degrees F., the danger point of overheating will be reached.

The tubes are then removed quickly from the machine and placed on the rolls, which roll the weld down on a mandrel, which finishes the weld by compressing and shaping it. The tubes should then be given a hydrostatic test.

(2) Procedure for safe-ending of tubes for firetube boilers by oxy-acetylene welding.

(a) The welders shall meet the requirements of Rule 14-8.

(b) The tubes and safe ends shall meet the requirements of specification S-17.

(c) The welding rod should be Oxweld No. 1 high-test or Oxweld No. 7 low-carbon rod or equivalent.

(d) Design of joint.

The joint recommended is the open single-vee, butt-type weld as shown in Fig. 1.

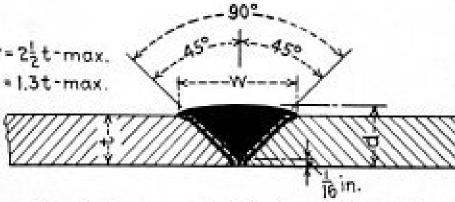

Fig. 1.—Recommended single vee butt weld

The pipe ends should be squared accurately and beveled to an angle of 45 degrees to within 1/16 inch on the inside wall.

Pipe ends should be accurately alined and properly spaced to permit fusion to the bottom of the joint. The pipe ends should be tack-welded at three points to maintain this alinement and spacing.

The weld metal should be thoroughly fused with the base metal at all sections of the weld and should penetrate to the bottom of the joint. If tubes are to be drawn through either tube sheet, they should be made practically flush with the pipe but should have no depression below the outer pipe wall.

(e) Preparation of tube for welding.

All scale, rust and other foreign material should be removed from the tubes at least over the area which would be affected by the welding heat.

(f) Welding.

The welding should be done in a flat position; that is, a rolling weld should be made in which the pipe is turned as the welding progresses, so that the welding is always done in a position convenient to the operator. Penetration to the bottom of the vee and fusion of the weld to the sides are essential and should be carefully done. The welds should be built up sufficiently so that there will be no low spots below the outer wall.

(g) Inspection and test should be made in accordance with Rule 14-18-2.

Spring Bar for Holding-on Flexible Staybolts

In the April issue, under the question of applying staybolts to locomotive boilers, various types of holding-on bars were illustrated, including the spring bar for holding on. This holding-on bar was one submitted for standardization by the committee of the Master Boiler Makers' Association and was included in the Official Proceedings of the Twentieth Annual Convention of the Master Boiler Makers' Association in 1929; from which the illustration published in the April issue was obtained.

I find, however, that this holding-on bar is a patented device, the patent being held by Mr. H. Lacerda, of Colonie, N. Y. I have no desire to infringe on the rights of others and for this reason am glad to bring this to our readers' attention.

G. M. Davies.

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California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

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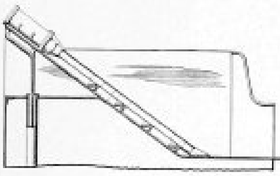
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,886,678. LOCOMOTIVE TENDER. FRANCIS HOGG, OF WESLEYVILLE, PENNSYLVANIA, ASSIGNOR TO THE STANDARD STOKER COMPANY, INCORPORATED, A CORPORATION OF DELAWARE.

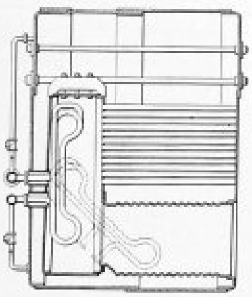
Claim.—The combination with a locomotive tender having a fuel bin,



of a reciprocable pusher for moving the fuel to the forward end of the bin pivotally mounted in said bin. Twenty claims.

1,887,754. SUPERHEATER FOR MARINE BOILERS. EDWARD ARTHUR GEOGHEGAN, OF NEW YORK, N. Y., ASSSIGNOR TO SUPERSTEAM GENERATOR COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim.—A superheater for a Scotch marine boiler, said boiler having a combustion chamber and a furnace leading thereinto, said superheater



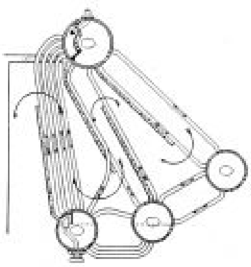
comprising a tube unit formed from one continuous length of tubing with a multiplicity of loops and tube portions connecting said loops with a saddle shaped configuration to provide for increased length of the tubing unit while still maintaining clearance for inserting the unit into the combustion chamber through the furnace of the boiler. Five claims.

1,887,891. PULVERIZED FUEL FURNACE. RICHARD ROOSEN, OF CASSEL, GERMANY, ASSIGNOR TO STUG KOHLENSTAUBFEUERUNG PATENTVERWERTUNG G. M. B. H., OF CASSEL, GERMANY.

Claim.—A pulverized fuel furnace having a firebox, a fire bridge therein, a powdered fuel burner mounted to direct fuel towards said fire bridge, secondary air supply passages arranged in the bottom of said firebox at least approximately in parallel with the entrance path of the fuel, an auxiliary fire bridge spacedly arranged below said fire bridge, and another secondary air supply passage opening into the space existing between said fire bridge and auxiliary fire bridge. Seven claims.

1,862,367. STEAM GENERATOR. LAWRENCE E. CONNELLY, OF CLEVELAND, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO FOSTER WHEELER CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

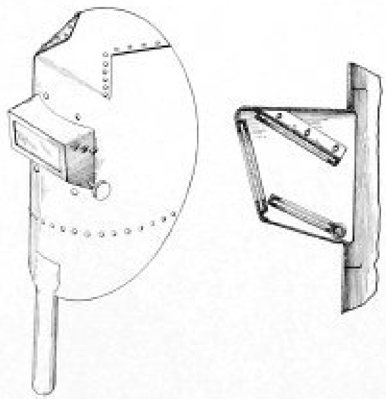
Claim.—In a steam generator, a mud-drum, a water drum above and in front of said mud-drum, a bank of up-flow water tubes connecting said mud-drum and water-drum, a steam liberating drum above and to the rear of said water drum, up-flow water tubes connecting said water drum and steam liberating drum, a bank of down-flow water tubes connecting said steam liberating drum and mud-drum, a steam and feed water receiving drum at the rear of said steam liberating drum, a bank of steam conveying tubes connecting the upper portions of said steam liberating drum and feed-water receiving drum, down-flow and up-flow feed-water tubes connecting said feed-water drum and mud-drum, a watertight chamber secured to the shell of and within said mud-drum enclosing the lower ends of said down-flow and up-flow feed-water tubes, a vertical watertight division plate secured to the lower portion of the shell of said



feed-water drum between said down-flow and up-flow feed-water tubes, means to supply feed-water to the down-flow side to said plate, and a series of down-flow tubes connecting said feed-water drum adjacent to said up-flow feed-water tubes and said mud-drum outside of said chamber. Three claims.

1,885,426. HELMET. OSCAR S. FLOOD, OF CHICAGO, ILLINOIS, ASSIGNOR TO SELLSTROM MANUFACTURING COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

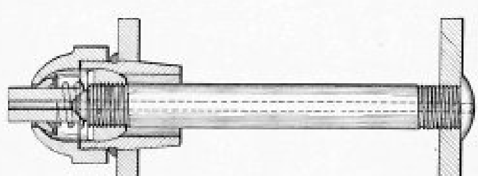
Claim.—A helmet of the class described comprising a body portion adapted to encompass the face and part of the head, a head harness for holding said body portion in a desired position, and a pair of arms



pivotally mounted on opposite sides of said harness, said arms having horizontally and vertically extending intercommunicating slots, and connecting means adjustably engaging said slots in a horizontal and vertical direction and secured to said body portion whereby the latter is universally adjustable. Thirteen claims.

1,868,083. STAY BOLT. THOMAS S. WHEELWRIGHT, OF RICHMOND, VIRGINIA, ASSIGNOR TO OLD DOMINION IRON & STEEL WORKS, OF BELLE ISLE, RICHMOND, VIRGINIA, A CORPORATION OF VIRGINIA.

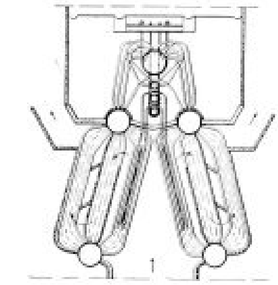
Claim.—In a staybolt structure, a casing comprising a sleeve and cap having outer and inner spherical seat surfaces, and said cap having an opening in its outer wall concentric with its seat surface, a bolt



having an end portion disposed in said casing and provided with an inner head member having a spherical seat surface pivotally engaging the seat surface of the sleeve, an axial extension projecting beyond said inner head member and projecting outwardly through the opening in the cap, the bolt and its extension being provided with a tell-tale hole extending continuously from end to end thereof, an outer head member slidable on the bolt extension toward and from the inner head member and having a spherical seat surface pivotally engaging the seat surface of the cap, and resilient means acting to force the outer head member outward and away from the inner head member and against said seat surface of the cap. Four claims.

1,866,387. SUPERHEATER BOILER. WILBUR H. ARMACOST, OF NEW YORK, N. Y., ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y.

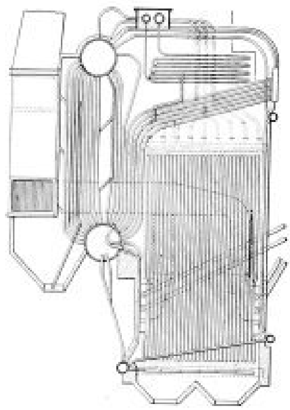
Claim.—A superheater boiler comprising a pair of steam generating units each having a steam and water drum, a superheater having an inlet header, an intermediate header connected to the inlet header, means



located above the level of the steam and water drums and forming a steam separating space, a plurality of relatively flexible tubes connecting the steam space of each of said drums and said means, and a plurality of relatively flexible tubes connecting said means and said intermediate header, there being a greater number of tubes between said drums and said means than between said means and said intermediate header. Seven claims.

1,866,307. STEAM GENERATING INSTALLATION. GEORGE P. JACKSON, OF FLUSHING, NEW YORK, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim.—A boiler comprising, in combination, an upper steam and water drum, a lower mud drum, vertically extending bent tubes connecting said drums, upper header means located to one side of the upper drum, a



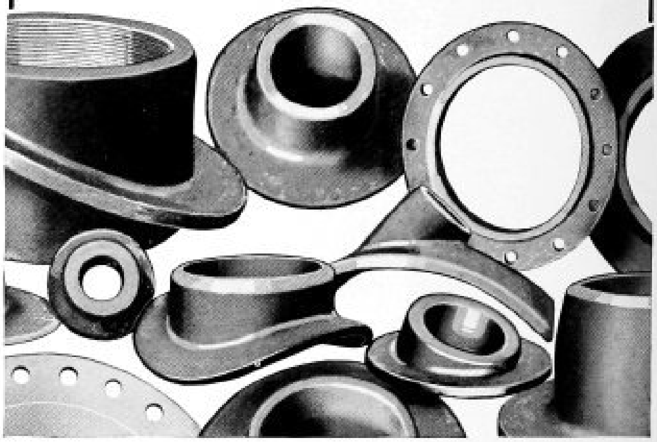
bank of tubes connecting the lower drum to said header means comprising a plurality of rows of bent tubes, said tubes extending vertically adjacent to the aforesaid vertically extending bent tubes for a portion of their length and substantially horizontally for the remainder of their length, tubes connecting said upper header means with the steam space of the upper drum, said last mentioned tubes and the substantially horizontal portion of said bank of tubes constituting the upper and lower boundaries of a superheater space, and a superheater located in said space. Eight claims.

1,861,965. STEAM BOILER. HOWARD J. KERR, OF WESTFIELD, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

Claim.—In a boiler having vertically disposed headers, a furnace, furnace wall cooling tubes, side wall water boxes inclined to the horizontal, and located at the lower portion of said furnace, said tubes being connected directly to said boxes, and connections from the lower portion of some of said headers to the upper ends of said water boxes. Four claims.

1,885,744. WELDER'S DEVICE. ROBERT MALCOLM, OF CHICAGO, ILLINOIS.

Claim.—A welder's device of the character described comprising a main body portion provided with an opening in the front wall, a housing disposed entirely about said opening and open at the front and rear thereof, a protection lens mounted across the open front, a pair of frame members removably secured to the opposite side walls within the upper end of the housing so as to slope downwardly toward the opening in the main body portion, means whereby said frame members are clamped in place and limited adjustment of the frame members permitted, a reflecting element supported at its ends by said frame members, a frame disposed transversely within the housing adjacent to the bottom thereof and pivotally secured at its rear end to the side walls of the housing so as to permit vertical swinging movement, a non-glare reflecting element mounted in said frame, and means disposed through the side of the housing whereby the frame may be tilted about the pivot of the frame.



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Boiler Maker and Plate Fabricator

Prospects Better for Boiler Industry

A feeling of optimism for the immediate future pervaded the annual meeting of the American Boiler Manufacturers' Association at Skytop Lodge, Skytop, Pa., early this month.

Production within this and its affiliated industries has advanced materially, with better prices being obtained and with the virtual elimination of the evils of unfair competition. This result has been achieved after three long years of concerted effort. Profits to members of the industry have not progressed in proportion. New laws, bringing added tax burdens, have curtailed the benefits which logically should accompany improved and efficient methods and management.

Practically the entire effort of the 1936 meeting was devoted to the furtherance of these improvements. Before the meeting concluded definite policies were adopted to unify the activities of the several branches of the industry. By co-operation between member companies during the next twelve months, it is believed that great progress will be made towards overcoming the difficulties still standing in the way of complete recovery.

A Message to Master Boiler Makers

O. H. Kurlfinke, boiler engineer, Southern Pacific Company and president of the Master Boiler Makers' Association, in a recent announcement to the membership calls attention to the importance of the business meeting to take place at the Hotel Sherman, Chicago, September 16 and 17. His statement concerning the meeting follows:

During the past year the association's active officers and various committee members have been diligently at work preparing the subject matter of the topics which are to be presented before the members for discussion.

Since conditions in our country are ever changing, particularly during the past several years, those who are successfully meeting the present-day requirements of industry should pass on to their fellow-men the results of their experience from improved methods which have been developed, or from improved shop management. This active association believes in keeping abreast of the times and, after giving the subject careful consideration, the officers have concluded that the most advantageous method of achieving this objective is to hold a meeting, where all may gather for an exchange of views. At the 1936 meeting there will be no display of exhibits. It will be strictly a business meeting.

With the ultimate good of the association in mind, proposals of vital importance will be submitted to the membership at this meeting. Not only will the meeting include the customary discussion of papers to be presented covering subjects of vital application to the boiler makers' craft, but the officers believe it necessary that the constitution and by-laws of the association be revised to incorporate instructions that should result in definite decisions being made by the full membership on recommended practices. These proposed constitutional revisions will also include changes in the organization among the officers, which will bring it more in keeping with present-day requirements.

These changes are designed not only to maintain the strong position of the association, but to advance the prestige it has enjoyed throughout its successful existence to new heights of achievement.

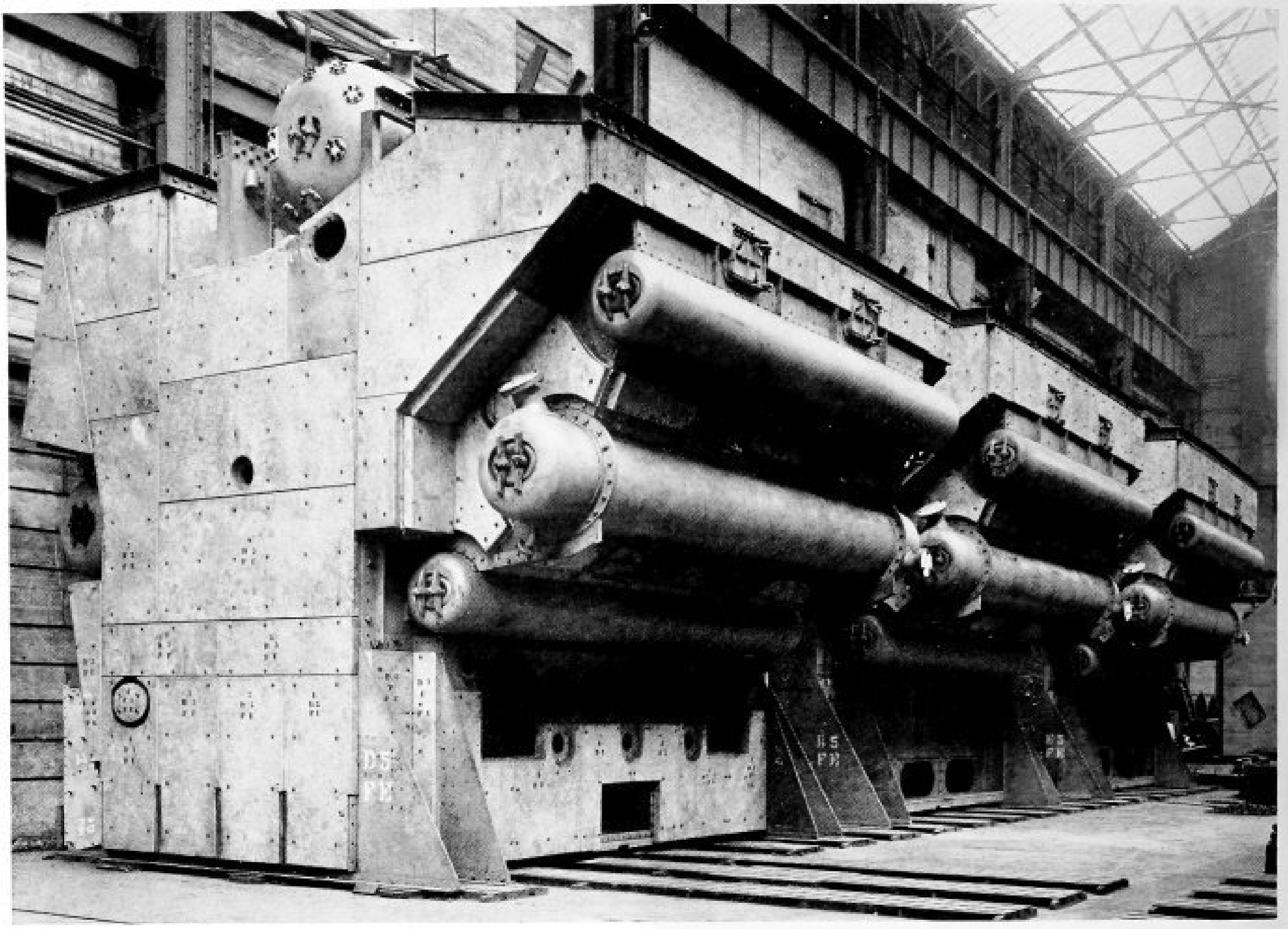
Locomotive Streamlining Makes Progress

The New York Central streamlined train *Mercury* soon to be placed in service on a daily round trip schedule between Detroit and Cleveland, features a fully streamlined locomotive, the work on the engine being carried out in the West Albany boiler shop. The second Pacific type locomotive to be rebuilt in this fashion is now under way in the same shop.

Passenger appeal is fundamentally the basis for this advance in locomotive design, which at the same time accomplishes material fuel saving when operating at high speed. The trend towards improvement in appearance by this manner of modernizing existing power is bound to advance at a rapid rate, as more of the crack trains adopt the mode. The New Haven, for example, in placing an order for ten steam locomotives recently with the Baldwin Locomotive Works specified streamlining as an essential.

Some months ago it was predicted that boiler shops would begin to experience some improvement in employment from work of this kind, since streamlining is a job that logically must be carried out by the boiler department. The experience of the West Albany shops bears this out, for the streamlining of the present two Pacific type locomotives created work for a number of boiler makers. As the program of modernization advances on this road, as it will rapidly, many more men will be required.

Water treatment, better materials and other factors, have reduced the amount of boiler maintenance necessary on the motive power of the country. Centralization of repairs has more or less helped to deplete the ranks of the boiler making fraternity. This new development, however, as it progresses will open new avenues of employment for the boiler makers' art, for as styles in automobiles have changed, so too has public demand for modern rail transportation altered the attitude of the railroad management towards modernization of their facilities.



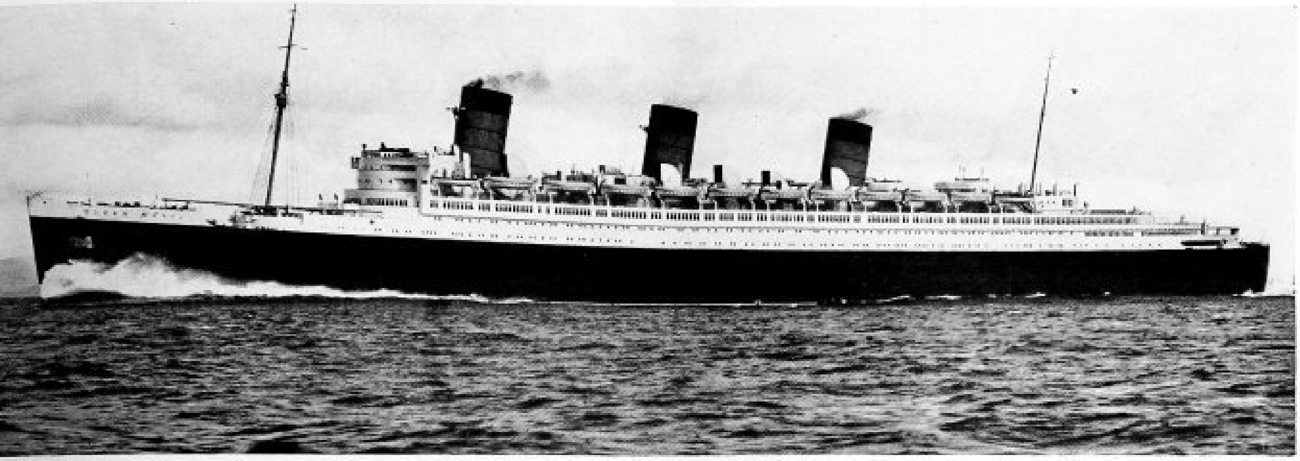
Battery of boilers for the Queen Mary set up in the shop

Boilers for the Queen Mary

In direct line of succession from the first Cunard steamer, the Clyde-built paddle steamer *Britannia* which on July 4, 1840, made transatlantic history by inaugurating the first regular North Atlantic mail and passenger steamer service, the new Cunard White Star superliner *Queen Mary*, which sailed from Southampton on May 27 on her maiden voyage to New York, represents the latest developments in naval architecture and marine engineering. The contract for the construction of the vessel was placed with the builders, Messrs. John Brown & Company, Ltd., Clydebank Shipyard, Glasgow, on December 1, 1930. Work was suspended on December 12, 1931, and resumed on April 1, 1934. The vessel was launched on September 26, 1934.

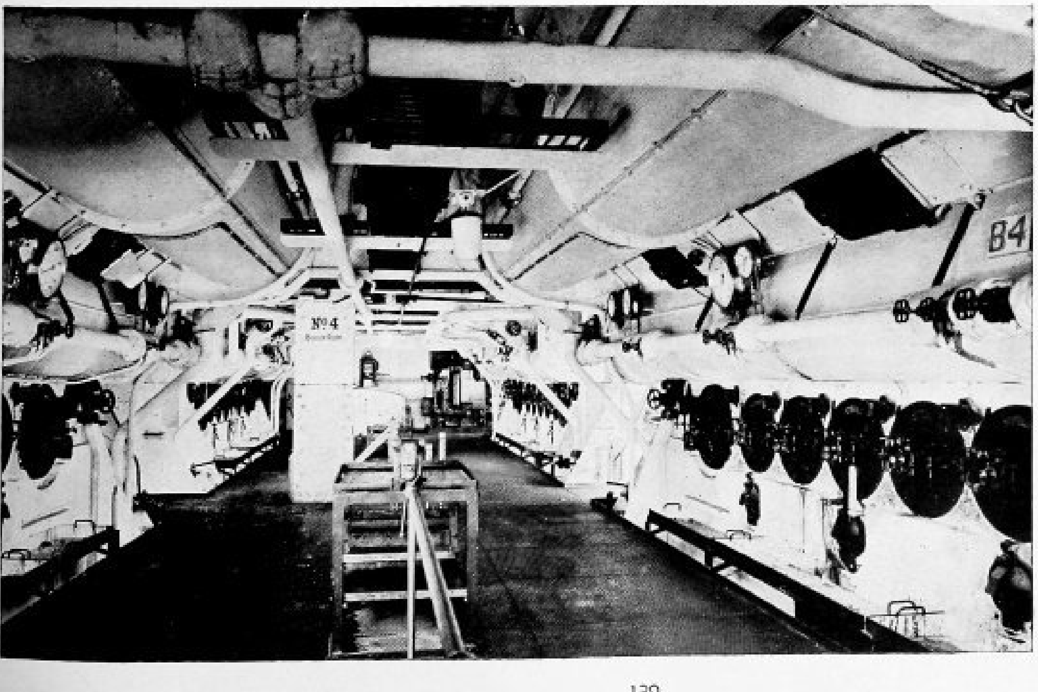
The underlying basis of the building of the *Queen Mary* is revealed in the statement of Sir Percy Bates, chairman of Cunard White Star, Ltd., to the effect that the size and speed of the new vessel is no greater than was considered essential by the owners to provide (with a similar ship) a contemplated weekly service between Southampton and New York. With due allowance for the minimum convenient time required by the turn-around, it was found that the lowest speed at which it was possible to make the voyage, even on the shortest of the accepted liner "tracks," was about 28½ knots. The speed attained on the trials represents the margin of power which the owners considered essential to meet the recognized severity of North Atlantic all-weather service.

To drive this mammoth liner 1019 feet 6 inches in length, 118 feet in beam, 124 feet in depth from the upper passenger decks to the keel, and with a gross tonnage of 80,733 tons, propelling machinery developing about 200,000 shaft horsepower is necessary. The propelling machinery incorporates the latest features of marine high-pressure and temperature practice. The vessel is propelled by four screws, each driven by an independent set of single-reduction geared turbines of the impulse reaction type, arranged in two separate compartments; the machinery for the outer screws being



installed in the forward engine room and that for the inner screws in the after engine room. The turbines are designed for the employment of steam between the pressure limits of 350 pounds per square inch (gage) and 0.5 pounds per square inch (absolute) with an initial steam temperature of 700 degrees F. Each main turbine set comprises one high-pressure, two intermediate-pressure and one low-pressure turbines, working in series; and each turbine drives a separate pinion which engages with the main gear wheel. For astern working, a single three-row impulse high-pressure stage is incorporated in the second intermediate ahead turbine casing and a single three-row impulse low-pressure stage is housed at one end of the low-pressure ahead turbine.

The steam generating equipment is arranged in four main boiler rooms, numbered 2, 3, 4 and 5. Six water-tube boilers are fitted in each room, making a total of 24 for the ship. The boiler rooms are operated under the closed stokehold system of forced draft. The boiler connections are so arranged that the boilers in rooms 2 and 4 work in conjunction with the forward main engine room and those in rooms 3 and 5 in conjunction with the aft main engine rooms. The boilers in each room are grouped in three rows there being two boilers



(Top) The liner Queen Mary on her trial trip. (Above) One of the main boilers being swung aboard. (Left) View in one of the boiler rooms in each row so that the working and firing spaces run fore and aft. The boilers which are side fired are designed to generate steam at a working pressure of 400 pounds per square inch and a temperature of 700 degrees F.

In the construction of each boiler are incorporated five drums, viz., one steam drum, three water drums and one superheater drum. The steam and water drums are hollow rolled forgings with ends integrally forged and machined inside and outside. Each steam drum is fitted internally with a steam separator in order to ensure that the steam may be dry before passing to the superheaters. The boiler casings are of robust construction and the several parts are closely fitted together to withstand the high air pressure in the boiler room. The end casings are of box section to resist bending in the event of the vessel being in collision. At the top of the inner plate of the end casings, a cradle is formed which supports the weight of the steam drum and part of the weight of the tubes and water drums while the water drums rest on an extension of the inner plate of the end casings, and are free to move outward and downward under the expansion of the tubes. The weight of the superheater is also carried on another extension of the inner plate of end casings. The hollow box construction of the end casings incidentally serves another purpose, namely that of a trunk to lead the heated combustion air from the air preheaters to an air passage formed under the combustion chamber of the boiler, and thence to the box on front of the boiler containing the air distributors and burners.

The principal heat radiating surfaces of the casing which are in the wake of the combustion chamber in addition to being lined on the fire side with asbestos millboard and firebrick, have air casings on the outside through which flows air for combustion purposes thereby keeping the inner casing from becoming overheated. In addition, the outer plates of the casing are insulated with fire felt and great care has been taken that the covering plates of the insulation are themselves insulated from the casing plates.

The boiler mountings include stop valves of self-closing design also automatic feed regulators. High lift safety valves are fitted on the superheater drum so that, in the event of the safety valves blowing off, the circulation through the superheater will be maintained. An additional safety valve also of high lift type is fitted on the steam drum loaded to blow off at a somewhat higher pressure than the main safety valves on the superheater. A low water alarm gear is also fitted in the steam drum. Oil burning fittings consist of seven burners to each boiler with their accompanying oil distributors and firebrick quarls. Two nozzle type steam soot blowers are fitted to each combustion chamber for cleaning the generator and superheater tubes, also two blowers of articulated tube type are fitted below the air heaters for cleaning the air heating tubes.

The waste gases from the boilers flow in parallel through the air heating tubes, which are in two sections, one on either side of the steam drum. At a point just before the two gas streams merge into one, a damper is fitted to control the flow of gas from each side of the boiler and by this means regulation of the superheat of the steam to the desired degree can be achieved. From thence the gases are led as directly as possible to their respective funnels, the subdivision of the gases from each boiler being carried up to the base of the lower funnel. The waste gases from Nos. 1 and 2 boiler rooms discharge into the forward funnel, Nos. 3 and 4 boiler rooms into the middle funnel and No. 5 boiler room into the forward section of the aft funnel. The after section of the aft funnel is occupied by a special separate division which carries off the hot air discharged from the galleys and escapes to the atmosphere through an opening in the plating at aft end of funnel near the top. The engine room ventilating fans discharge into the space in the aft funnel around the galley division, escapes to atmosphere being provided through openings in the funnel plating near the top.

The three outer funnels are of elliptical section and all of the same area, but the heights of each funnel are different, with a view to carrying the smoke clear of the passengers on deck. The inner funnels are generally rectangular in section and the smoke from each boiler room is carried separately on the top of the funnel.

The forced draft for the watertube boilers is on the closed stokehold system, the boiler room being sealed from the outer atmosphere. While the boilers are working under forced-draft conditions, access to the boiler rooms can only be had through airtight air locks. These air locks are arranged at "E" deck for entrance to the boiler room and at the firing platform level for intercommunication between the boiler rooms. The steel plate screens which close the boiler rooms are situated in the funnel hatch at "C" deck and close the space between the uptakes and the funnel hatch casing, thus cutting off communication with the outer atmosphere except through the air locks and certain valves arranged in the screen whereby a small proportion of the air under pressure in the boiler rooms may be discharged up the funnel hatch for cooling purposes. These valves are controlled from the working passage on "D" deck and can be shut from that position should a fire occur in the boiler room. The control levers are enclosed in a glass-fronted box to prevent unauthorized interference with the control levers.

There are eight double inlet forced-draft fans in each boiler room, thirty-two in all for the watertube boilers. They are arranged in pairs with a driving motor for each pair placed between the two fan casings. Two pairs of fans are placed in separate rooms on each side of the ship on "E" deck immediately above and alongside of the boilers. The characteristic of these fans is such as will allow a considerable variation in the speed of any pair of fans from that of the remainder of the fans, without the danger of blowing back on the slower running fans. The fans discharge through a short trunk directly into the boiler room and by a system of longitudinal and athwartship screens the air is distributed at a convenient height above the boiler room floor for ventilation purposes, thereafter the air takes an upward course toward the air inlets to the air preheaters. Each discharge trunk is fitted with a balanced valve, automatic in its action, so that if a motor cuts out with consequent stoppage of a pair of fans, the valves in the discharge trunks of the particular pair of fans stopped will be automatically closed by the resultant flow of air from the boiler room. The control levers of the valves are also connected by a system of wire rope pulls to levers placed in a glass-fronted box, open to the working passages on "D" deck so that in the event of a fire in the boiler room, access of air through the fan discharge trunks can be shut off from outside the boiler room.

In No. 1 boiler room are installed three double-ended cylindrical boilers working on the closed ashpit system of forced draft. These boilers supply superheated steam to the hotel turbo generators and saturated steam for all the various ship's services. Each boiler is 17 feet 6 inches mean diameter, and 22 feet long and has eight

One of the auxiliary Scotch boilers being lowered into the ship

oil-fired corrugated furnaces of the suspension type, 3 feet $7^{11}/_{16}$ inches internal diameter. The working pressure is 250 pounds per square inch and the smoke tubes of the center nests are fitted with superheater tubes, these being of sufficient capacity to give a superheat of 200 degrees F., at the boiler stop valve. The smoke tubes of the wing furnaces are fitted with spiral retarders, and the back ends of the furnaces are designed to allow easy withdrawal for overhaul. The plain and stay smoke tubes of the cylindrical boilers are of lap-welded Corrostite steel as are also the tubes of the air heaters. Each cylindrical boiler steam space is fitted with a steam separator through which the steam must pass to have the entrained water extracted before admission to the superheater. As already mentioned the uptakes for waste gases from the cylindrical boilers are led into and occupy the forward section of the forward inner funnel.

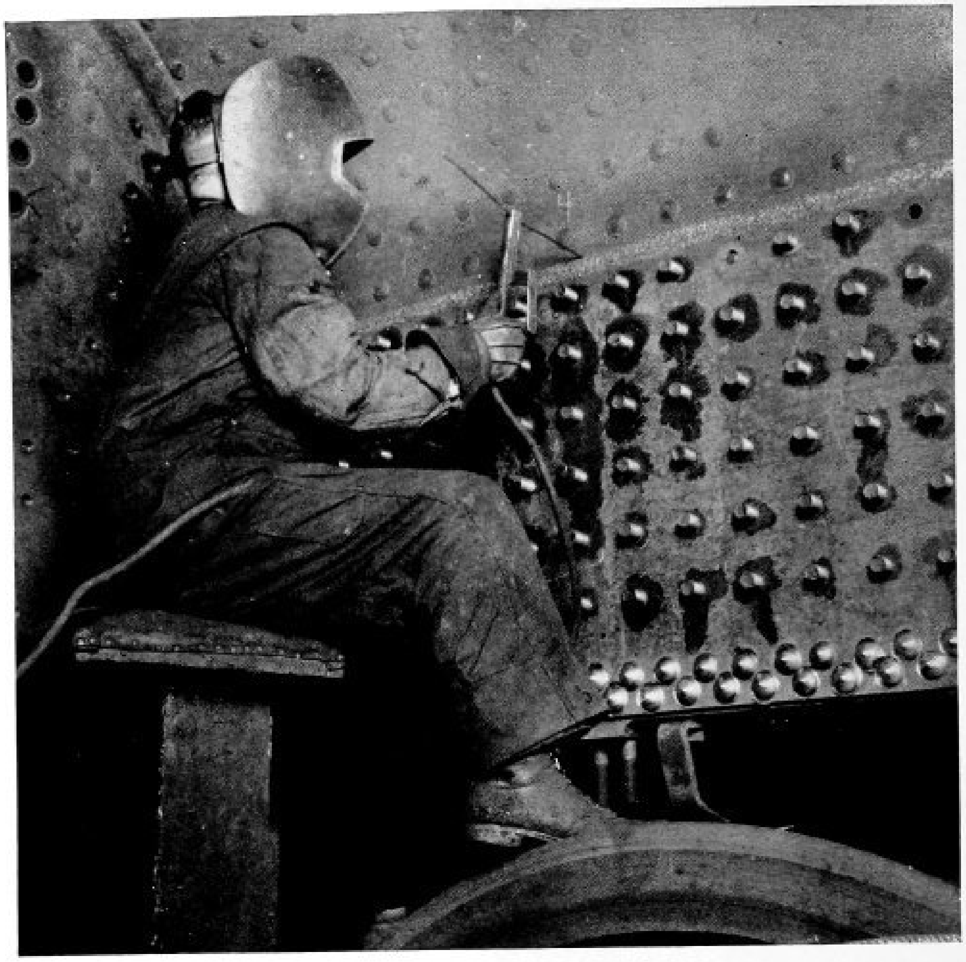
Four single inlet forced-draft fans supply combustion air to the furnaces of the cylindrical boilers.

Appliances are fitted to ensure smokeless and economic combustion. These include smoke observation glasses to each furnace and gas sampling fittings to each boiler end, also long distance thermometers fitted for observation of the temperature of the escaping waste gases.

Oil is supplied to the boilers by two oil-burning units, one being motor-driven and the other a steam-driven set, and an electric heater is supplied for use when raising steam. A steam-driven pump of 100 tons per hour capacity is supplied to transfer either oil or water and it is so arranged that it can discharge through an oily ballast separator capable of dealing with 150 tons per hour.

Otis Steel Opens New York Office

The Otis Steel Company has opened an eastern district sales office in the Chrysler Building, New York City, E. J. Kulas, president of the company announced today. E. A. Steif, who for many years has represented the company as manufacturers agent in the east, has been appointed manager of sales for the New York district.



Heavy locomotive repairs demonstrate

Southern Pacific Welding Practice

By Frank A. Longo*

The following details of welding and cutting cover the practice of the Southern Pacific Company in carrying out heavy locomotive repairs, with particular emphasis on boiler work:

Electric arc and gas welding and cutting are used to great advantage in roundhouses, car shops, boiler, blacksmith and machine shops; also for sheet metal workers and pipe fitters, for new and repair work in various branches of the metal trades. We find them indispensable for quick, efficient and economical results.

The success of a welding job depends a great deal on how it is prepared and for this reason the welder should see that the work to be done is properly beveled and edges thoroughly cleaned from dirt, scale and grease. Work should be secured in position with suitable strut bolts, clamps or wedges, with the proper opening to enable the welder to perform the welding all the way through the plate or job, and make the weld solid.

When an engine is shopped, the tender is disconnected from the locomotive and sent to the tank shop. The locomotive is placed on the strippers' pit, wh a gang of strippers removes all pipes, jacket, laggi cab fixtures and running boards. Binders and bra rigging are loosened, so they can easily be dropped wh the engine is placed in the back shop.

After the engine is placed over the pit in the b shop, the heavy stripping is done—such as dropp binders, brake beams, safety hangers. The cab is moved, as are the front end, superheater units, thro box and stand, air pumps, feed water pump, injec air reservoirs cylinder heads, pistons, crossheads, m and side rods and all brackets on boiler. We h well-trained oxy-acetylene cutters in the stripping g who burn all bolts and nuts to facilitate the remo of parts mentioned. The engine is then lifted

* Welder supervisor, Los Angeles General Shops, Southern Pacific pany.

wheels removed. Engine and trailer trucks, booster engine, spring rigging, shoes, wedges and driving boxes are then removed and taken to their respective departments.

During the time the strippers are on the engine we have three cutters who cut out bolts and rivets in the ash pan, for removal; then burn out firebox sheets, radials and staybolts. We usually have the firebox burned out before the strippers are done. Flexible bolts and radial bolts are burned off next to both sheets for reclaiming. The boiler is then lifted from the frame and taken to the boiler shop. Frames, frame braces and cylinders are cleaned and examined for cracked or broken parts.

Of the various processes of fusion welding, the electric-arc process is, in the large majority of cases, the most economical for use either in repairing broken locomotive frames or introduction of a new section to replace an old, crystallized section.

By the use of treated water and the continual renewal of patches and sections of fireboxes and front flue sheets in the back shop the necessity for new fireboxes is a thing of the past and fortunately so, for it is an expensive proposition to strip and remove a boiler from the frame for this work. A few years ago it was: "How many fireboxes can you put in?" Now it is: "How many fireboxes can you save?"

I recall the old, slow method of applying patches in fireboxes with patch bolts and sewing up cracks with plugs. Hot workers were continually working on leaky stays, flues, rivets, plugs and patch bolts. Boiler makers, in those days, were in demand, as we had several all along the line keeping fireboxes tight.

I have before me a chart showing the number of fireboxes applied during the last twenty-three years. It is very interesting to note in the last few years the reduction in the number of fireboxes applied. In the twelve-year period from 1913 to 1924 a total of 2127 fireboxes were applied on the Pacific System. In the eleven-year period from 1925 to 1935 this dropped down to 977 fireboxes. At Los Angeles during the year 1920, we put in 104 fireboxes. In 1925 this dropped down to 36 and in 1935 only one firebox was applied.

With our old method of acetylene welding, patches and cracks in side sheets were common cause of failures on the road. Men had to be sent from our shop to reweld these cracks at outside points. Joining sheets in the locomotive firebox by the electric-arc process, using a heavy-coated welding rod, has effected considerable economy, both in firebox construction and maintenance cost. Welds equal to or better than the plate itself in tensile strength, ductility and ability to withstand repeated stresses are obtained.

On rare occasions we do have to put in a new firebox. These combustion chamber fireboxes consist of crown, door, back flue, two side, throat and bottom combustion chamber sheets. Sheets are held in place with straps and strong backs. The only riveted seams we have in this type of box are the door and flue sheets, which, I hope, our people will see fit to let us weld some day; as, when we apply patches to door sheet or bottom of back flue sheet without removing all lower flues, we weld them in.

The type of weld used in new fireboxes is the single "V" butt weld and, as the welders have access to both sides of the sheet, the seams must be welded from both sides. After the box has been welded completely from the fire side a diamond-point chisel is then used and a "V" shaped groove is cut in the back of the weld of sufficient depth to remove all flaws. This groove is then welded and a weld of maximum strength is secured. Calking edges of door sheet, flue sheet and four mud ring corners are sealed with electric welding.

The life of a new firebox is extended by the application of reinforcing bars, door and flue sheet top knuckles, properly fitted to flanged radius welded vertically between each row of staybolts. These are butted up against the crown sheet and extend along the knuckle down to midway between the first and second rows of staybolts. Bars on throat sheet wings are placed hori-

zontally 4 inches apart, and ½-inch thick back mud ring corner patches are applied instead of ⅜ inch, as all of these give trouble first, due to cracking, and are the weak spots of a firebox. The application of these ⅝-inch round iron bars, length to suit, has extended the life of these parts from 100 to 150 percent.

In the welding of patches in fireboxes, front flue sheet and smoke box, the edges of both the old and new sheets must be clean and beveled at a 30-degree angle, or 60-degree opening for both. The new sheet should be bolted so that a gap of 1/16 inch is left. The seam is tack welded about every 15 inches, this so the patch can not get out of line, after which the straps are removed. Patches are applied to any part of the firebox. The first bead, or pressure bead, is made with ⅛-inch diameter welding rod to insure penetration, as the weld in the water side must be clean and flush with the sheets and with no gaps or mud-catchers. The first bead is laid directly in the center of the seam. No attempt should be made to fill the gap with the first bead. After the first bead is applied, 5/32-inch and 3/16-inch diameter electrodes should be used and each layer of weld metal must be thoroughly cleaned of all scale.

In the repair shop, when applying tops of door sheets, back flue sheet and throat sheet wings, these bars are applied before patches are set in place. In applying patches to the front flue sheet, enough flues must be removed to enable the welder to reinforce the weld from the water side. Usually the whole knuckle below the unit header is removed and three patches are applied.

If the back flue sheet is renewed, a ¾-inch front flue sheet is applied instead of patches; that is, the front flue sheet is cut horizontally above the top row of flues to save removal of the unit header. This top section is well braced. Deterioration and cracking are not so rapid. Half-inch gusset plates are welded to the knuckle of the front sheet in the smokebox side. The life of cracked front flue sheets has been extended by the welding of the crack and the application of these gussets.

Front flue sheets ¾ inch thick have been applied to three locomotives which are still in service. One applied to engine 4311 December 18, 1925, is ten years old. One ¾-inch front flue sheet applied to engine 4302 December, 1926, and removed January 11, 1934, gave eight years of hard service. The ¾-inch thick front flue sheet applied to engine 4320 in January, 1928, is still in service, after eight years. The ¾-inch thick front flue sheet applied to engine 4354 on April 18, 1932, is still in service.

The welding of superheater flues to the back flue sheet was one of our first applications of welding. In 1916 the average cost to weld in a set of thirty-six superheater flues with the oxy-acetylene method was $66, as the welder finished only one flue per hour. We now electric-weld this same set of flues in four and one-half hours at a cost of $6.

It was O. B. Schoenky, now superintendent of motive power of the Southern Pacific Company, and one of the pioneers of welding, who first saw the possibilities of electric welding replacing the oxy-acetylene method for our work. In April, 1917, he wrote the following to Pat Sheedy: "Now that the demonstration has been completed on autogenous welding we should adopt the apparatus that will give us the best results for the least money, which other roads have already proven is the electric welding outfit." The result was that in the following year, 1918, we purchased our first electric welding machine. At the present time we have eighteen electric welding machines, with two shifts of welders, and three machines in the roundhouse to take care of running repair work.

The holes in the back flue sheet for superheater flues are countersunk at a 45-degree angle half-way through the sheet. The flue is cut so that it will lack about 1/16 inch from coming through the sheet in the firebox. The flue is then given a light rolling to set it to sheet and then prossered as close to the sheet as possible. The flue is belled out or laid over in the countersink, after which the flue is welded with a good substantial bead, fusing well into the end of the flue to make a strong welded joint. There is no projection of the weld on the firebox side, as this weld is flush with the sheet and will run the life of the flues without giving a bit of trouble.

We do not weld our small flues until the life is about gone from flue beads. They are expanded, beaded, rags cut, cleaned and sandblasted for welding. A small bead is then welded around the flue bead and their life extended about fourteen months. In combustion chamber fireboxes it is much longer.

Oxy-acetylene welding is used in the repair of pit holes in flues and in the welding in of pieces of superheater flues. In the welding of superheater flues the bottom of the "V" is fused together before filler rod is added. This makes a solid weld of maximum strength and the weld is always flush with the inside flue walls. After the ash pan is bolted in place all seams are electric welded to insure against cold air striking firebox sheets and falling of brick work.

On our type "E" superheater units we have experienced quite a bit of trouble, due to units scaling up, burning and bursting at the ends nearest the fire. Different kinds of compounds and mixtures of acids were tried to remove scale, without results. This problem was temporarily solved by cutting the units off 24 inches from the ends nearest the fire and rewelding, after reaming tubes out with an 8-foot reamer. This did not do a clean job, as it left a thin layer of scale on walls and was not an ideal condition. After a few months' service scale was easily formed again, causing engines to be tied up for leaky units.

Sandblasting was then tried out with good results. A 20 foot ⅜-inch pipe was inserted in the tube and a thorough job of cleaning was accomplished. The time and cost to cut these units was rather high, as this was all done with a hand hacksaw. Later this time and cost were cut down less than one-half by the acetylene cutter burning two holes in the ends of the units and reaming large enough to insert the pipe for sandblasting. Holes were welded after sandblasting.

One of the newest processes used in the railroad shop is the method of applying metals to surfaces with the metal spray gun. We have done some testing of metal spraying equipment and find that we can reclaim our scrap monel pump rods and sleeves from feed-water heaters by spraying with monel metal. High carbon steel was sprayed to wearing surfaces of bronze link blocks and the life of these blocks was extended three to five times. This highly resistant wearing surface prevents galling of the link in the link block. This method of applying metal has possibilities in the railroad field, such as spraying surfaces to prevent corrosion.

The use of welding in the repair and general maintenance of shop machinery is of foremost value. Repairs are made to machinery, castings and parts that could not be accomplished by other methods, thereby putting disabled equipment back into service in quick time and at a fraction of the cost of new parts and avoiding delays in getting the equipment back in service.

The process also has made possible the construction and fabrication of many facilities that otherwise would not be provided. Special tools and jigs are easily constructed with welding, which are highly valuable in efficient and economical shop operations. We have had some interesting and unusual experiences in our shop such as: Our large electric air compressor in the power house, that supplies the shop with air, was disabled by an accident. A large hole was knocked through the wall into the water space by the valve dropping through a worn valve seat. On first examination the hole appeared to be about 8 inches by 10 inches but on taking this large cast-iron cylinder to the shop and after removing the head we found cracks extending under the cylinder head.

All loose and cracked material was removed. To have ordered a piece of cast iron from the foundry would have required two days. The coefficient of cubic expansion is about the same for steel, so we rolled and fitted a piece of steel 1.25 inches by 14 inches by 18 inches. Before the plate was fitted in we applied a ¼-inch layer of bronze on this steel plate so the cast iron piston head would not ride on steel. A furnace was built around this casting the same night and the welding job was completed next day. Casting was allowed to cool and same was bored out and new seats applied. Air compressor was put in service again in the least possible time.

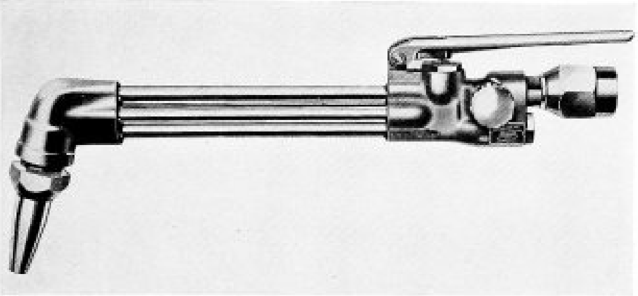
At another time one of our traveling cranes was disabled by the collapse of a cast-iron motor rotor spider. We fabricated one out of steel plates and machined it to size. This was balanced by drilling holes in the end plates. As the crane was put up thirty-one years ago it would have been impossible to replace the rotor spider in a limited time. The crane was back in service in six days.

When engines come in the shop that have met with accidents such as pilot beams, tender frame castings and tender end sills broken, the broken parts are fabricated of boiler plate and welded together. Several months ago we repaired the most completely wrecked cast-steel tender frame I have ever seen. The rear end of cast-steel tender frame was completely broken and crushed in. Approximate cost of new section was about $2500 and time to cast same and ship to us from the East would have held this tender out of service ninety or more days. The back tank head was removed, straightened and defective portion renewed. Rear end was completely fabricated from boiler plate and two forgings we had made in our blacksmith shop. This was done at a fraction of the cost of new parts and avoided the long delay in getting the tender back in service. Approximate cost was $445.

The scrapping of locomotives and cars are operations of importance to our railroad. Undoubtedly the oxy-acetylene cutting torch is the major and most important tool employed for this work. Without it the operations could not be carried out on the present profitable basis, as the cost of scrapping by entirely mechanical methods would in most cases be prohibitive. During the year 1935 841 cars, 22 locomotives and 14 tenders were cut up at our scrap dock in Los Angeles.

Oxy-acetylene Cutting Attachment

An oxy-acetylene cutting attachment, known as the Oxweld Type CW-22, has been announced by the Linde Air Products Company, 30 East Forty-second street, New York, N. Y. This cutting attachment incorporates features of design and possesses a range of performance which permit it to handle light sheet metal as well as all but the heaviest work at speeds equal to those of the full-size cutting blowpipe. The Type CW-22 attachment operates on either low-pressure or medium-pressure acetylene and can be used on either the Oxweld Type W-17 or W-22 welding blowpipe handle, thereby extending the utility of these two blowpipes.



Oxweld Type CW-22 cutting attachment

Sturdy, smooth operation at all pressures is said to be given by the new streamline injector and by the improved type cutting valve, with removable seat, centralized under the cutting lever. The mixed-gas passage is formed by three Ambrac tubes. The length and the four 90-degrees changes of direction afforded by this type of construction give exceptional flashback resistance. The body and head of the CW-22 attachment are designed to combine strength and lightness. The body is of pressure-forged bronze while the head is a manganese bronze forging.

Cause of British Marine Boiler Explosion

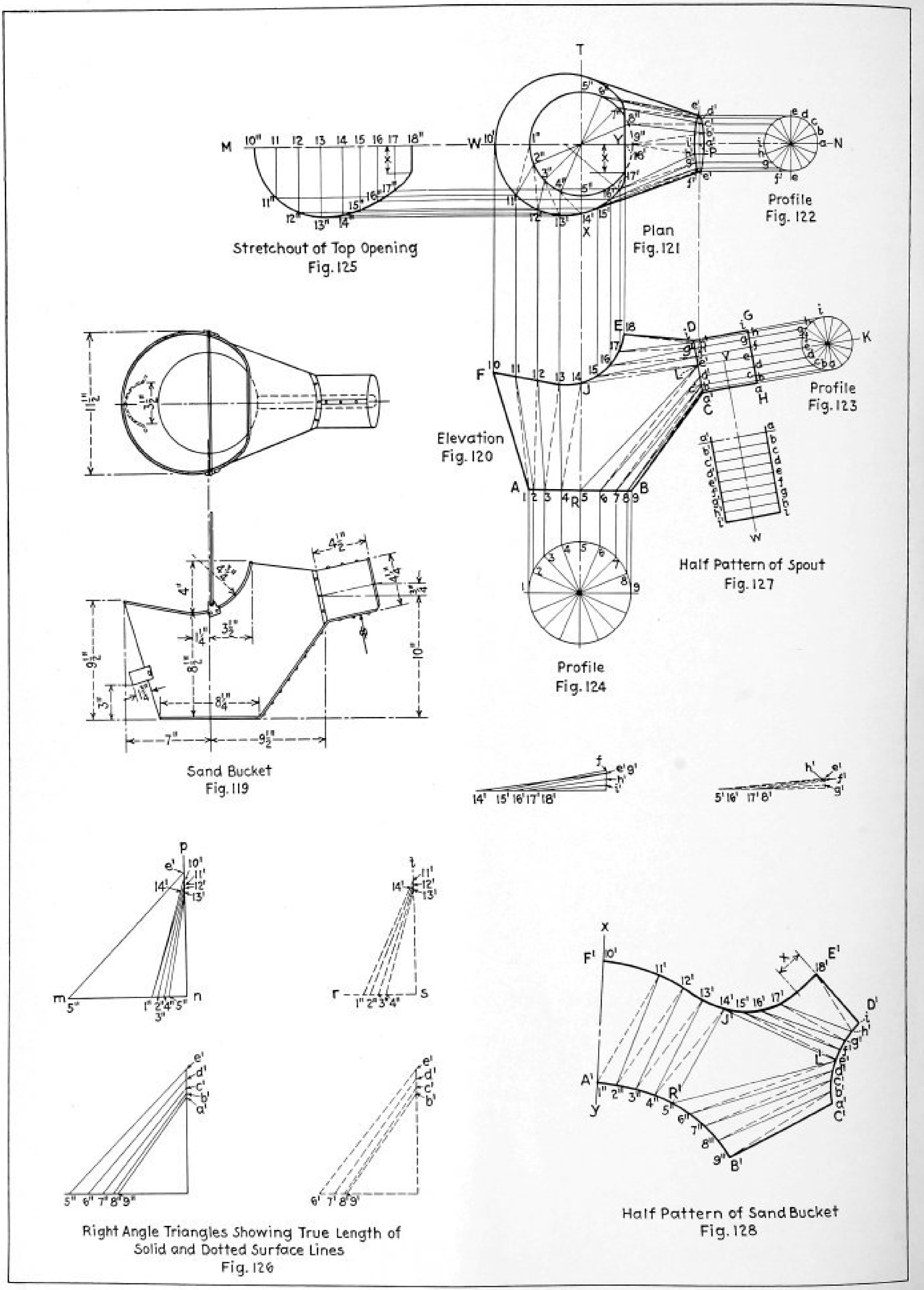
The results of an inquiry held by a British Board of Trade surveyor into the circumstances surrounding an explosion from a marine type boiler in the steamer *Dicky* which occurred on December 28 last, while that vessel was in the River Ouse, have just been announced.

It was found that the cause of the explosion was a faulty jointing surface on the face of the manhole. The engineer surveyor-in-chief, in his observations on the accident, writes:

"The failure of the manhole door joint was apparently due to the defective condition of the jointing surface of the manhole. Sufficient attention is not always given to maintaining the condition of the manhole doors. While failures of this kind may not result in injury to any of the attendants, the hazard to the vessel when it is necessary to remake the joint, particularly when one boiler is provided for propelling purposes, may be serious."

1935 Edition A.S.M.E. Locomotive Boiler Code

The 1935 edition of the Boiler Construction Code, devoted to locomotive boilers and prepared by the American Society of Mechanical Engineers, is now available at the headquarters of the society, 29 West 39th Street, New York. This edition incorporates a number of revisions authorized by the boiler code committee and approved by the council which were published in the addenda sheets.



Development of sand bucket

PRACTICAL PLATE DEVELOPMENT—XIV

Sand Bucket

By George M. Davies

The sand bucket to be considered is illustrated in Fig. 119. It consists of body and spout. The body is developed by triangulation and the spout by the radial line method of development.

To develop the sand bucket layout the elevation and plan views as illustrated in Figs. 120 and 121 respectively. The outline is taken on the neutral axis of the plate and any allowance necessary for fabricating the joints is omitted. To complete the outline of the connection to the spout in the plan view, on the center line *K-L* draw the profile, Fig. 123, and divide same into any number of equal parts; the greater the number of equal parts taken the more accurate the final development. Sixteen are taken in this case. Number the intersections on one-half of the circle from *a* to *i* as shown, then parallel to the center line *K-L* draw lines through the points *a* to *i*, extending same into the elevation, cutting the line *C-D*. Number these intersections from *a'* to *i'* as shown.

On the center line *M-N*, draw the profile, Fig. 122, and divide it into the same number of equal parts as was taken in Fig. 123. Number these points from *a* to *i* as shown. Then parallel to the center line *M-N* draw lines through the points *a* to *i*, Fig. 122, and extend them into the plan.

Next draw a line parallel to the line *L-P*, passing through the point *a'* of the elevation and extend it into the plan, cutting the line just drawn parallel to *M-N* through the point *a*, Fig. 122, locating the point *a'*, Fig. 121. In like manner obtain the points *b'* to *i'*, Fig. 121.

After locating the points *a'* to *i'*, Fig. 121, as shown, step off the distance from each point to the center line *L-P* on the opposite side of *L-P* and in this way complete the profile of the connection as shown.

The first step in developing the sand bucket is to note that the object is symmetrical about the center line *M-N* and therefore a development of one-half of the object will be all that is necessary; a duplicate of the pattern obtained, completing the required pattern.

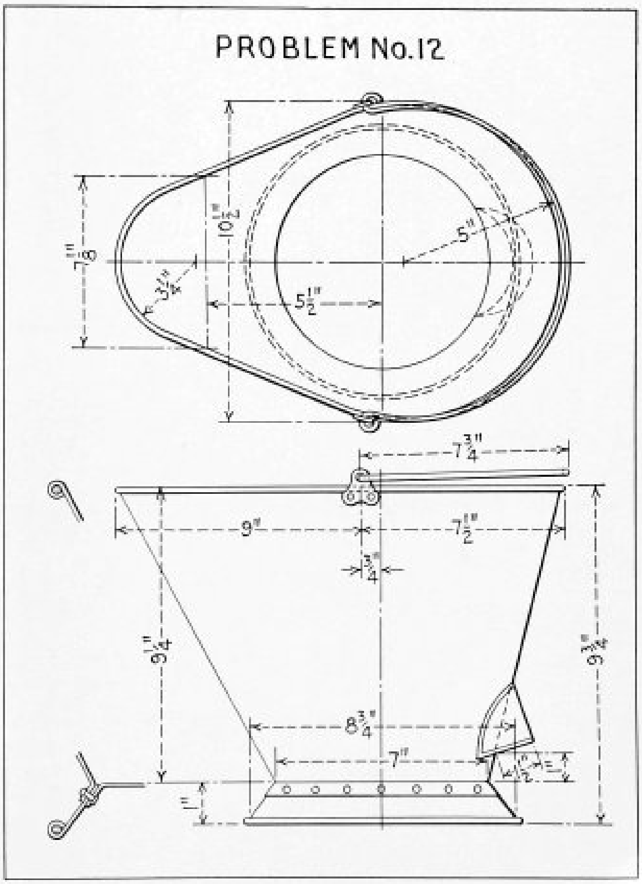
The next step is to divide the object into separate parts, each part of which can be developed as an individual unit, and then by combining the individual parts obtain a complete pattern. The sections into which the object is divided are shown in the elevation as *A-R-J-F* the rounded back, *R-J-L*, the triangular sides, *R-L-C-B* the rounded bottom, and *J-L-D-E* the rounded top. Thus by dividing the object into small sections and by developing each part separately the pattern is obtained with less complication.

To develop the section *A-R-J-F*, first draw the profile, Fig. 124, and divide same into the same number of equal parts as was taken in profile Fig. 123. Number the points on the half circle from 1 to 9 as shown. Parallel to the center line *S-T* draw lines through the points 1 to 9, Fig. 124, cutting the line *A-B* of the elevation; number these points from 1 to 9 as shown. Then divide the line *F-J* into four equal parts or one-fourth of the total number of parts taken and number these points from 10 to 14 as shown.

Then parallel to the center line *S-T* draw lines through the points 10 to 14 and extend them into the plan, cutting the line *W-X*, locating the points 10' to 14'.

Divide the bottom of the plan into the same number of equal parts as was taken into the profile, Fig. 124;

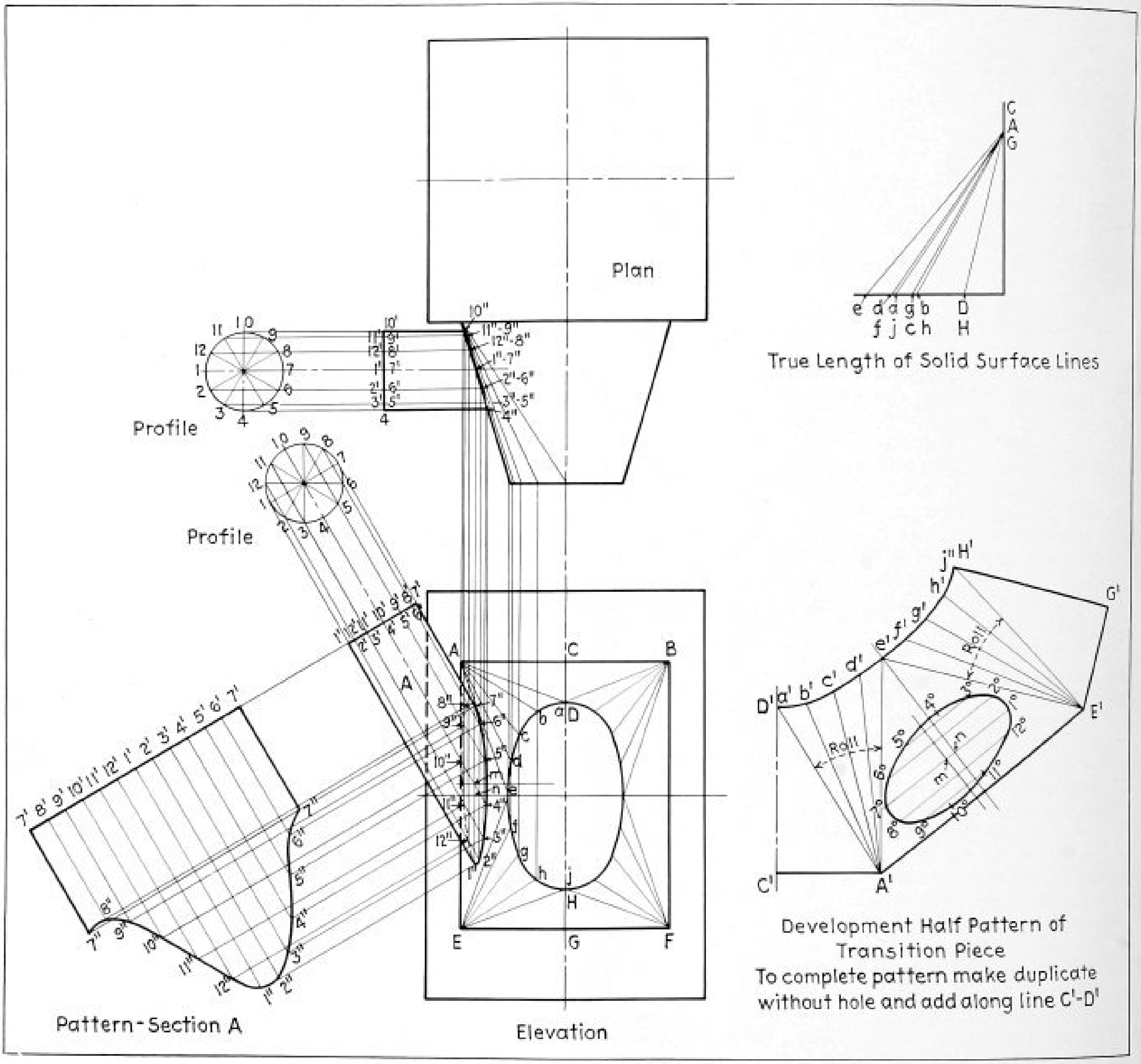
Problem No. 12 for Readers to Lay Out



The correct solution of Problem No. 12 will be published in the August issue

Problem No. 10—Correct Layout

Breeching Header



Problem No. 10 was published on page 93 of the April issue. Above is the correct layout of this problem, which may be used by readers as a check against their solutions

number the points from 1″ to 9″ in the manner shown in Fig. 121.

Connect the points 1-10, 2-11, 3-12, 4-13, 5-14 of the elevation with solid lines and the points 1-11, 2-12, 3-13, 4-14 with dotted lines; these lines represent the surface lines of the object and to obtain their true length a series of right angle triangles is constructed as shown in Fig. 126.

The altitudes of the triangles are taken from the elevation and are measured vertically from the line *A-B* to the points 10 to 14. The bases of the triangles are measured directly from the plan, the points 1″-10′, 2″-11′, 3″-12′, 4″-13′, 5″-14′ of the plan being connected with solid lines and the points 1″-11′, 2″-12′, 3″-13′, 4″-14′ with dotted lines corresponding to the same line in the elevation.

To determine the true lengths of the surface lines, draw any line as *m-n*, Fig. 126, and at *n* erect a perpendicular to *m-n*. On *m-n* from *n* step off the distance *n*-1″ equal to 1″-10′ of the plan, locating the point 1″, Fig. 126, and on the perpendicular *n-p* step off the distance *n*-10′ equal to the perpendicular distance between the line *A-B* and the point 10 of the elevation, locating the point 10′, Fig. 126. Connect the points 1″-10′, Fig. 126, which line will be the true length of the surface line 1-10 of the elevation. Continue in this manner making the bases *n*-2″, *n*-3″, *n*-4″, *n*-5″ equal to 2″-11′, 3″-12′, 4″-13′ and 5″-14′ of the plan respectively and the altitudes equal to the perpendicular distances from the line A-B to the points 11, 12, 13 and 14 of the elevation, the lines 2″-11′, 3″-12′, 4″-13′, 5″-14′, Fig. 126, being the true length of the solid surface lines 2-11, 3-12, 4-13, 5-14 of the elevation.

In like manner in the diagram *r-s-t*, Fig. 126, determine the true lengths of the dotted surface lines.

The next step in developing the section *A-R-J-F* is to obtain the true length of the top opening *F-J*, as shown in Fig. 125. On the line *M-N* step off the distances 10″-11, 11-12, 12-13, 13-14 equal to the distances 10-11, 11-12, 12-13, 13-14 on the line *F-J*, Fig. 120. Erect perpendiculars to the line *M-N* through these points and then parallel to the line *M-N* draw a line through the points 11′ of the plan cutting the perpendicular just drawn at the point 11 of Fig. 125, locating the point 11″, Fig. 125. In like manner locate the points 12″, 13″, 14″, Fig. 125. Connect the points with a line, which will be the true length of the top opening as shown by F-J of the elevation.

Having obtained the true lengths of all the lines involved in developing the pattern of section *A-R-J-F*, proceed to develop the pattern by drawing any line as *x-y*, Fig. 128, and step off on this line the distance 1″-10′ equal to the distance *A-F* of the plan or 1″-10′ of Fig. 126. Then with 10′ as a center and with the dividers set equal to the distance 10″-11′, Fig. 125, scribe an arc. With the point 1″, Fig. 128, as a center and with the trams set equal to the length of the dotted line 1″-11′, Fig. 126, scribe an arc cutting the arc just drawn locating the point 11′, Fig. 128.

Then with 1″, Fig. 128, as a center and with the dividers set equal to the distance 1″-2″ of the plan scribe an arc. With the point 11′, Fig. 128 as a center and with the trams set equal to the length of the solid line 2″-1′, Fig. 126, scribe an arc, cutting the arc just drawn locating the point 2″, Fig. 128.

Continue in this manner using the distances 2″-3″, 3″-4″, 4″-5″ from the plan, the distances 11″-12″, 12″-13″, 13″-14″ from Fig. 125, and the lengths of the solid and dotted surface lines from Fig. 126 completing the pattern to the line 14′-5″, Fig. 128.

The next step is to obtain the true lengths of the surface lines of the triangular section *R-L-J*. The true length of *R-J* is shown as 14′-5″, Fig. 126; 14′-5″ of the plan is taken as the base of the triangle and the perpendicular distance between *A-B* and the point 14 of the elevation is the altitude of the right angle triangle.

The true length of *R-L* is shown as *e*′-5″, Fig. 126. The distance *e*′-5″ of the plan is taken as the base, and the vertical distance from the line *A-B* to the point *e*′ of the elevation is the altitude of the right angle triangle.

The true length of *J-L* is shown as *e*′-14′ of Fig. 126. The distance *e*′-14′ of the plan is taken as the base and the vertical distance between the point 14 and the point *e* of the elevation is taken as the altitude of the right angle triangle.

To proceed with the pattern, with the point 5″, Fig. 128 as a center and with the trams set equal to *e*′-5″, Fig. 126, scribe an arc; then with 14′ as a center and with the trams set equal to 14′-*e*′, Fig. 126, scribe an arc cutting the arc just drawn, locating the point *e*′, Fig. 128.

The sections *R-B-C-L* and *J-L-D-E* are developed in exactly the same manner as for the section *A-R-J-F*. The true lengths of all the surface lines are obtained from the right angle triangles as shown in Fig. 126. The stretch out of the top opening for the section *J-L-D-E* is obtained in the same manner as for *A-R-J-F*. These points are shown in Figs. 125 and 126. Continue the pattern in the same manner as for the section *A′-R′-J′-F′*, completing the sections *R′-B′-C′-L′* and *J′-L′-D′-E′* as shown.

The completed pattern of the sand bucket does not provide for seams, so sufficient stock should be added all around for the joints and seams as shown in Fig. 119. A duplicate of this pattern joined along the line *x-y* completes the pattern of the sand bucket.

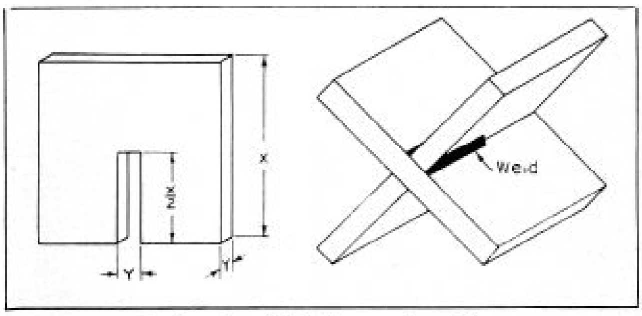
To develop the half pattern of the spout draw the line *v-w* perpendicular to the center line *L-K* and on *v-w*, Fig. 127, step off eight equal spaces, equal to the distance *a-b, b-c, c-d, d-e, e-f, f-g, g-h, h-i* of the profile, Fig. 123.

Draw lines through these intersections parallel to *L-K*. Extend *C-D* and *G-H*, cutting these lines locating the points *a* to *i* and *a*′ to *i*′, Fig. 127, completing the half pattern of the spout. The pattern does not provide for seams and sufficient stock should be added all around for the joints and seams as shown in Fig. 119.

Welding Aids
Vee Block Fabrication

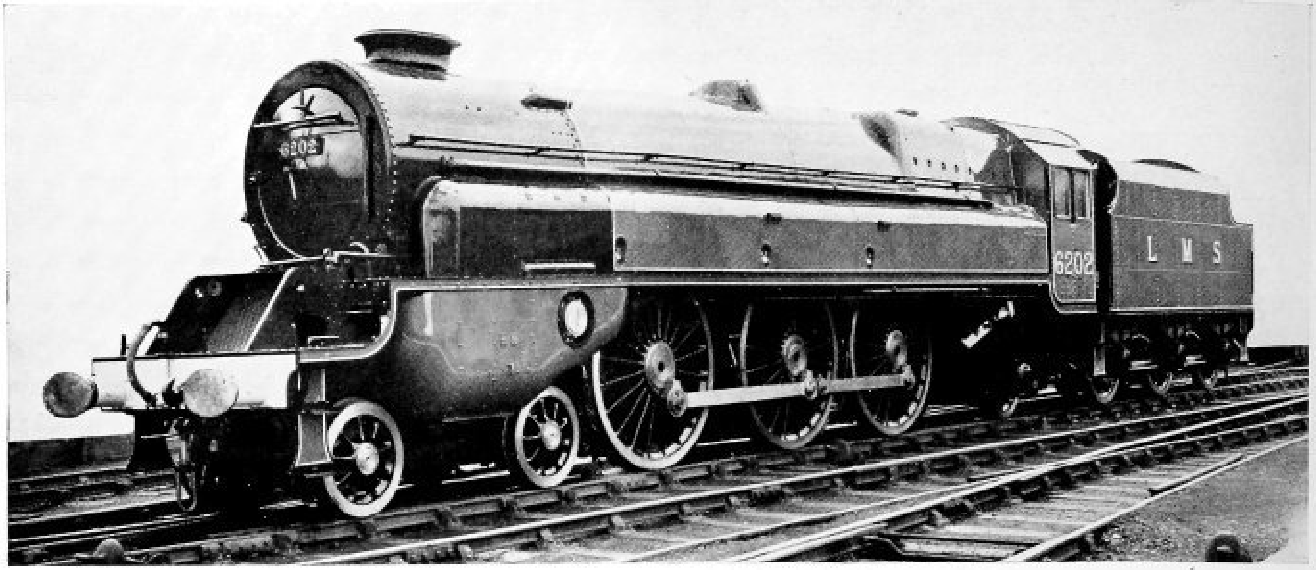
A simple method of fabricating vee blocks was recently reported which may suggest a way for other shops to save money in obtaining a supply of these useful work holding devices. Many welding shops find this type of fixture an indispensable aid in positioning work for welding.

Steel plate is used as the material. The thickness is not important, although the blocks should be of sufficient weight to make them heavy enough for practical purposes. Probably ½-inch material would be most suitable as a minimum size because stability can be gained by the weight of the blocks. Steel 1 or 1½-inch thick would provide enough weight for larger and heavier work. Several such vee blocks of varying size and weight will always be found of value, and it is advisable for even greater convenience to have at least two of each size. This is particularly true in lining up such parts as small crank shafts or tubular members.



Details of vee block for use in welding

By means of a carefully guided cut, shape two squares of steel of the relative proportions shown in the accompanying sketch. Then in from the center of one edge of each piece cut out a slot of the same width as the thickness of the steel plate and in depth equal to one half the length of a side of the other steel square. The two pieces of steel will then fit together in a simple joint. The block is then completed by making a fillet type weld as shown in the sketch. It will probably be found that the use of the bronze-welding process will make this job faster and will result in less possible effect from the heat of the flame.



Left-hand side of L.M.S. non-condensing turbine locomotive—Control mechanism and piping are concealed by the housing above the running board

London, Midland & Scottish testing

Pacific Type Turbine Locomotive

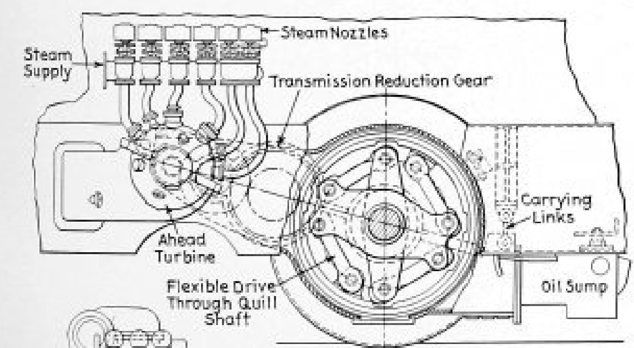
The London, Midland & Scottish Railway has recently completed at its Crewe Works a turbine locomotive, No. 6202, built for test purposes. This locomotive, which is of the Pacific type, is fitted with a non-condensing turbine of the Ljungstrom-Lysholm type, the turbine and the reduction gearing being designed and supplied by the Metropolitan Vickers Electrical Company, Ltd. In reality two turbines are employed, an ahead turbine located on the left-hand side in the place usually occupied by the reciprocating-engine cylinder and steam chest and a reverse turbine located on the right-hand side. The ahead turbine has six nozzles, two Curtis stages and several expansion stages. It is permanently connected to the triple-reduction gear located between the frames underneath the smokebox. The reduction gear is coupled to the leading pair of driving wheels by means of a quill drive of a general design similar to that used on some electric locomotives. This turbine develops over 2000 horsepower at full admission. The reverse turbine, which is smaller, has three nozzles and two Curtis stages. When the locomotive is running ahead the reverse turbine is disconnected.

Until recently the L.M.S. has employed 4-6-0 type locomotives in handling its heavy passenger traffic. In 1933, however, a design was worked out for a 4-6-2 type locomotive and two engines—Princess Royal, No. 6200, and Princess Rose, No. 6201, were built and placed in service. These locomotives had four single-expansion cylinders, 16¼ inches by 28 inches, 78-inch drivers, 250 pounds boiler pressure, 40,300 pounds rated tractive

Elevation of the London, Midland & Scottish turbo-locomotive force, and weighed 234,000 pounds in working order, exclusive of tender. The boilers had 2713 square feet evaporative heating surface, of which 190 square feet was in the firebox and 2523 square feet in the tubes and flues. To this should be added 370 square feet in the 16 superheater elements. These locomotives were designed to handle trains weighing from 500 to 560 tons (2000 lb.) between London and Glasgow and permit a reduction in the running time of trains already noted for their high speeds.

After the highly satisfactory performance of the first two Pacific type locomotives built in 1933 orders were given for the construction of ten additional locomotives in 1935, which carry numbers 6203 to 6212, inclusive. The modifications made in the design at this time were slight, aside from certain changes in the boiler. A combustion chamber 43½ inches long was added which increased the firebox heating surface from 190 to 217 square feet. Instead of 170 tubes 2¼ inches in diameter and 20 feet 9 inches long employed in the original boiler design, the number was reduced to 112 tubes, 19 feet 3 inches long. The original boiler had, in addition, 16 flues, 5⅛ inches in diameter, while the new boilers have 32 flues of the same diameter. These changes reduced the tube and flue heating surface from 2523 square feet to 2097 square feet. The superheater elements, which have an outside diameter of 1¼ inches, provided 370 square feet heating surface in the original design and 653 square feet in the revised design. The first two boilers were designed to furnish steam at 550 degrees F. temperature, and the later boilers at 750 degrees F., the temperature of saturated steam at 250 pounds boiler pressure being 406 degrees F. From the changes described it will be noted that the volume of the firebox has been increased which should improve combustion and that the superheating capacity has been raised appreciably.

The boilers are of the Belpaire design, which is quite widely used in Great Britain, and the fireboxes are of copper. The firebox sheets are ⅝ inch thick and the back flue sheet 1 inch thick. The foundation or mud ring is level at the back and then slopes downward at the front. On the inside the firebox is 91¾ inches long,



General arrangement of turbines and reduction gear showing method of driving the leading axle

Front view showing oil-cooling radiator below the smokebox

being 66¼ inches wide at the back and increasing to a width of 76⅝ inches at the front. The grate area provided is 45 square feet.

The distance from the bottom of the mud ring to the center line of the boiler is 82¾ inches at the front and 15 inches from center line to the crown sheet. At the back end the distance from the bottom of the mud ring to the center line is 74⅞ inches and from the center line to the crown sheet the distance is 11⅞ inches.

The barrel and firebox wrapper sheets are of 2 per-cent nickel steel. Welding, in addition to riveting, is employed on the seams of the wrapper sheet and along the longitudinal barrel seams for a distance of 12 inches from each end. Circumferential barrel seams are welded at the bottom for a distance of 2 feet on each side of the center line. Welding is also used around the corners of the mud ring and at several other points. Monel metal stays, ⅞ inch in diameter, 11 threads, are employed on the two outer side rows and on the top six rows and also in the curved portion of the throat. On the back head the top three rows are of copper, ⅞ inch diameter, 11 threads, and the balance are of mild steel, ⅝ inch diameter, 11 threads.

The boiler is fed by means of an exhaust-steam injector located on the fireman's side. This injector uses exhaust steam from the ahead turbine and discharges through a feedwater heater also supplied with exhaust steam from the ahead turbine. A live steam injector is provided on the other side of the locomotive.

The height of the stack above the top of the rail is only 13 feet 3 inches and the width of the engine overall is 9 feet. The space permitted over the crown sheet is 2 feet. No steam dome is provided. The steam pipe is of the collector and dryer type, with inlet at the highest point above the back tube sheet. The throttle is incorporated in the superheater header.

The boiler used on the turbine locomotive, No. 6202, is the same as the later design employed on the ten conventional locomotives built in 1935. In running gear and in all other details possible the turbine locomotive is the same as on the others of the group so that comparative values may be obtained in service.

The turbines are bolted to the outside of the plate frames at the front end, the ahead turbine on the left-hand side and the back-up turbine on the right-hand side. The turbine spindles are at right angles to the track or parallel to the locomotive driving axles. The ahead turbine is flexibly coupled to the high-speed pinion of the triple-reduction gear. The gear mechanism, which is of the double-helical type and enclosed in a fabricated gear case, is suspended from three supports on the engine frame, one at the front end and two at the rear. Provision is made in the first and second pinions for slight flexibility in order to equalize the pressure along the gear teeth.

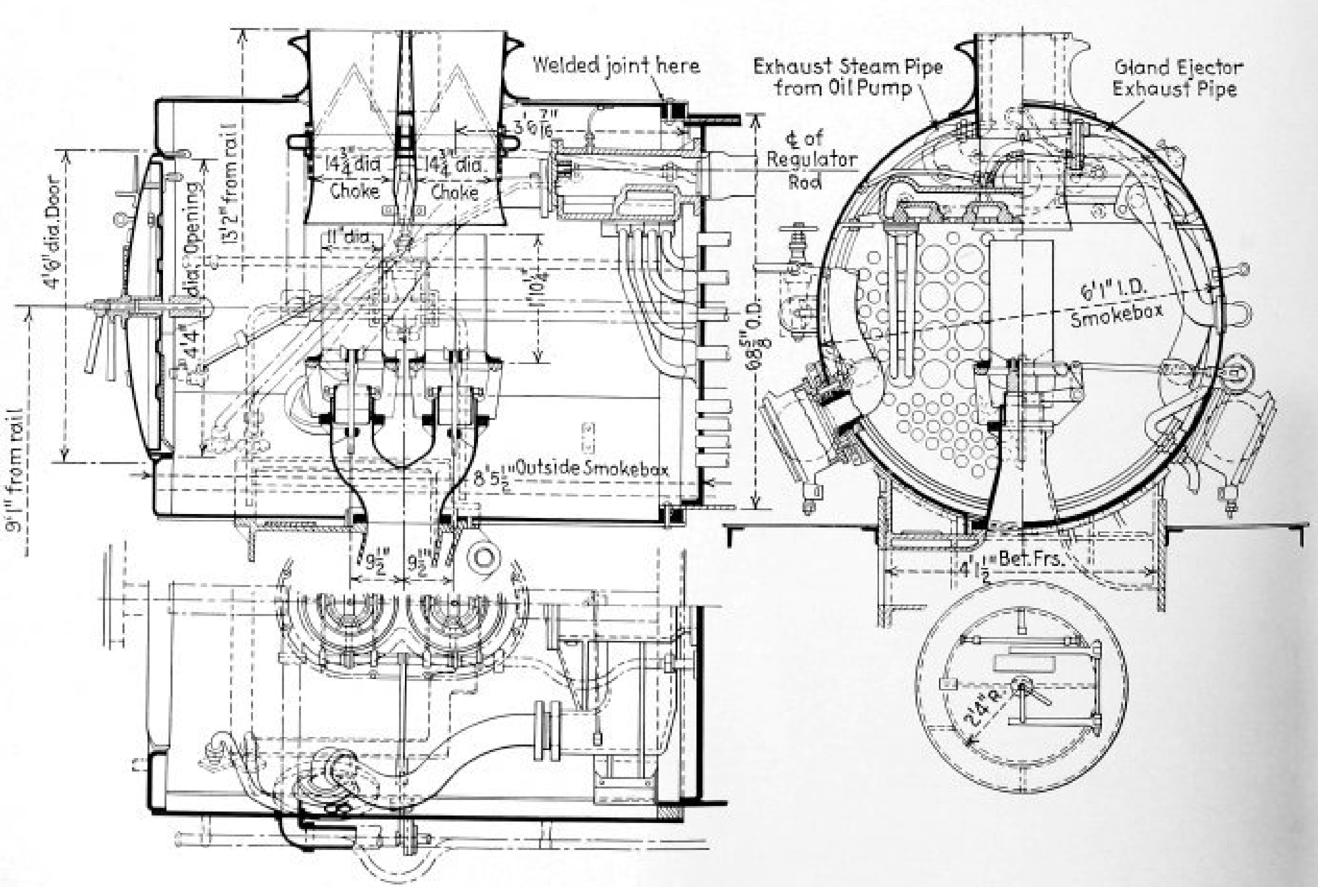
Steam from the superheater header, after passing through the main throttle valve, which is always kept open while the locomotive is in operation, is led to steam chests on the right- and left-hand sides in a manner similar to ordinary practice. Its passage from the steam chests to the various turbine nozzles is controlled by regulating valves operated from the control box on the left-hand side of the cab immediately in front of the engine man. Both turbines exhaust to the atmosphere through double variable nozzles and a twin stack. A back pressure as low as 2 pounds per square inch is anticipated.

The smokebox on the locomotive has several unusually interesting features. The substitution of a turbine for a reciprocating steam engine necessitated a number of changes, as might be anticipated in view of the fact that the turbine exhaust is practically a steady blow and that the anticipated exhaust pressure is only two pounds. A double exhaust pipe and smokestack was adopted. This permitted the exhaust pipes from several of the auxiliaries to be carried up in the space between the two parts of the stack. The combination of the two stacks in a single casting has been well worked out and does not detract from the appearance of the locomotive. In order to assure the desired draft regardless of the number of nozzles opened to the turbine a variable type of exhaust nozzle is employed. As will be noted from the drawing the design used provides a central conical plug which is raised and lowered automatically as the amount of exhaust steam is increased or decreased. Straight petticoat pipes, 11 inches inside diameter, are employed. The inside diameter of the stacks at the point of choke is 14¾ inches.

The operation of the turbines non-condensing has made it possible to simplify the design greatly as compared with that required for a condensing turbine locomotive. The method of controlling the turbine by several nozzles provides a wide range of flexibility and should assure a high economy.

National Metal Congress and Show

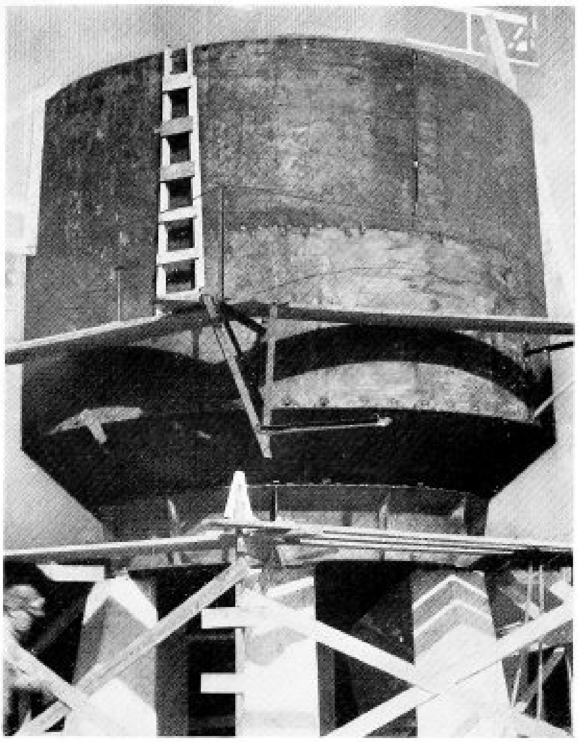
Eighty-five percent of the exhibit space in the huge underground exhibit hall of Cleveland's Public Auditorium has been contracted for by exhibitors in the eighteenth annual National Metal Show, to be held October 19 to 23, inclusive, in conjunction with the National Metal Congress.



Smokebox of the L.M.S. turbo-locomotive with double, variable exhaust nozzle

Fabricating Nickel-Clad Steel Plate*

By F. P. Huston† and T. T. Watson††



Caustic soda settling tank fabricated of nickel-clad steel

The maintenance of a continuous nickel surface is the only problem new in the design of pressure vessels and other types of equipment. The accompanying drawings, Figs. 14 to 27, show methods of construction which provide continuity of the nickel surface at top reinforcing curbs, flanges, outlets, and fittings.

Figs. 14 and 15 show top reinforcing curbs for open vessels in the lighter plate gages. The reinforcement of tanks in gages too thick to flange is accomplished by welding on steel angles, as in steel work. Pure nickel sheet may be applied over the top flange of the angle and welded to the nickel-clad plate, if desired.

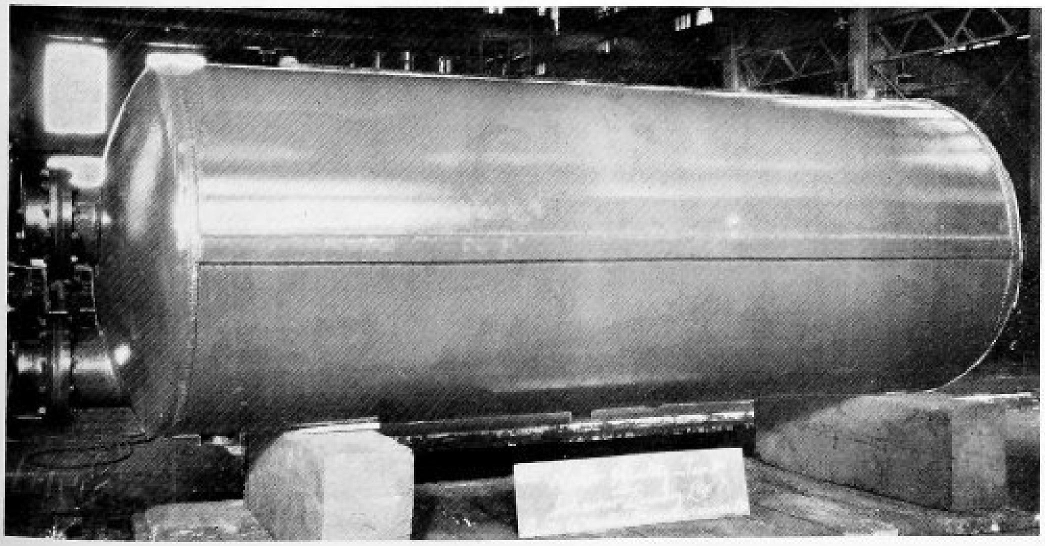
Design

The methods illustrated in Figs. 16 and 17 may be used for flared and dished cover plates on vessels that operate under pressure or vacuum.

Jackets are readily welded to nickel-clad vessels as illustrated in Figs. 18, 19 and 20. Any type of bottom outlet, either in solid nickel or nickel-clad steel, may be attached.

Forged, tapped welding flanges in solid nickel up to 4 inches are available and may be applied either as shown in Fig. 21 or 22, with preference given to Fig. 21. Small tappings, about 2 inches and under, may be ma-

* Second instalment of an article appearing on page 108 of the May issue.
† Development and Research Department, The International Nickel Company, Inc.
†† Development and Service Metallurgist, Lukens Steel Company.



Nickel-clad water heating tank of 1000 gallons capacity, length 11 feet 4 inches, 48 inches diameter

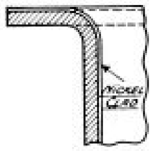


Fig. 14

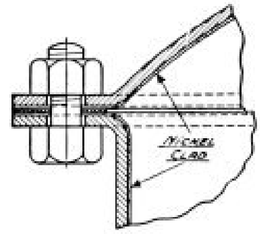


Fig. 16

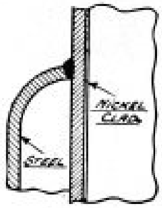


Fig. 18

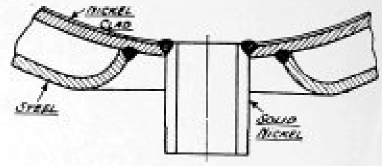


Fig. 19

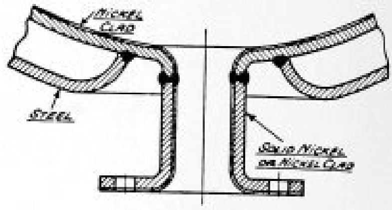


Fig. 20

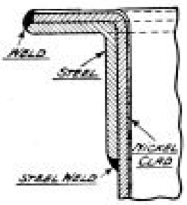


Fig. 15

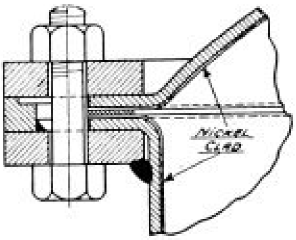


Fig. 17

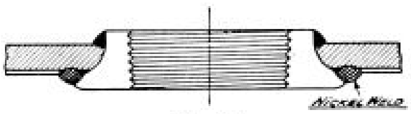


Fig. 21

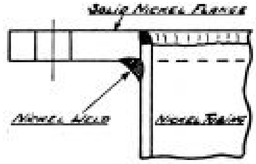


Fig. 24

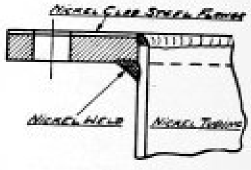


Fig. 25

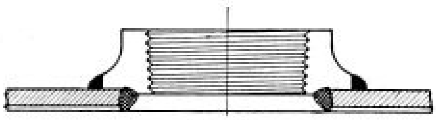


Fig. 22

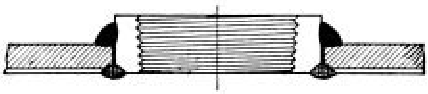


Fig. 23

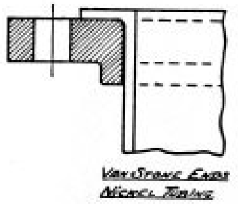


Fig. 26

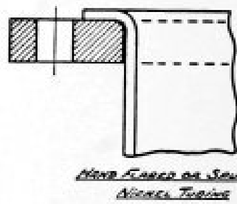


Fig. 27

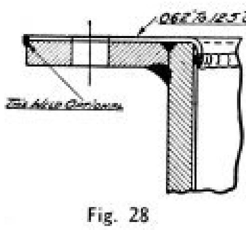


Fig. 28

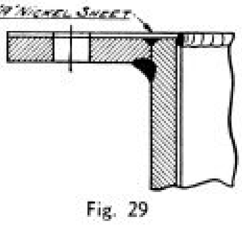


Fig. 29

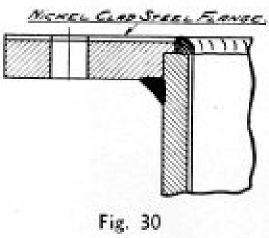


Fig. 30

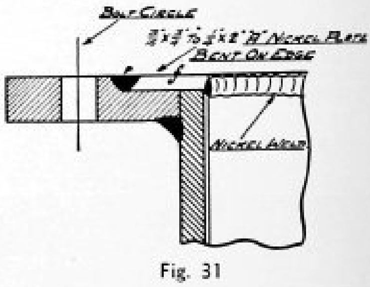


Fig. 31

chined from solid nickel bars and welded as in Fig. 23.

Built-up flanged fittings, as shown in Figs. 24 and 25, or loose flanges, as shown in Figs. 26 and 27, are suitable for outlets to 6 inches. Figs. 28, 29 and 30 show suitable designs for large outlets, handhole, and manholes. Fig. 31 may be used for large flanges and is a particularly good design for bolted joints in evaporator shells, or similar large vessels, when machining facilities are available for facing the flanges.

Formed Heads and Fittings

Standard boiler heads, flanged flat heads, flanged and dished heads, elliptical heads, flued openings for manholes, hand holes, evaporator downtakes, tank manhole flanges, and, in fact, practically any formed shape is obtained in nickel-clad steels. The material responds readily to hot spinning, hot and cold pressing, and hand shaping in the production of these various shapes.

The dimensions shown in Fig. 32 are essential for the production of hot spun heads. Cold pressed, flat flanged, and flanged and dished heads are obtainable in a wide range of sizes and gages. Circles for cold pressing should be specified "annealed."

Pressed tank manhole flanges are available for storage tanks. They may be used to advantage with flared and dished covers for low-pressure vessels.

Forged and tapped welding flanges in solid nickel, van-stoned ends in solid nickel, seamless tubing with steel flanges, nickel castings, and other accessories required in the construction of tank and plate work can

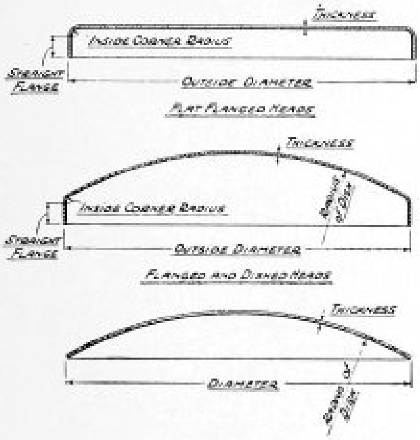


Fig. 32

be procured either from the sources supplying nickel-clad plate or from companies which they may recommend.

Applications

Combining the corrosion resistance and other advantages of pure, solid nickel with the economy of plain steel, Lukens nickel-clad steel permits fabrication of heavy equipment at a saving of from one-third to one-half the cost of solid corrosion-resisting materials. Some of its applications in equipment used in the chemical and allied industries are:

Alcohol storage tanks
Alum tanks and molds
Autoclaves
Barrels
Beer storage tanks
Bins
Black stock dry boxes
Brine tanks
Blower and exhaust fan bodies
Carbon tetrachloride storage tanks
Caustic soda settling tanks
Caustic soda crystallizer bodies
Causticising equipment
Chlorinators
Chutes
Condenser shells
Cooling tanks
Conveyor troughs
Covers, tank
Crutcher bodies
Crystallizer bodies
Digester bodies
Dissolving tanks
Drinking water supply tanks
Drums
Dye liquor tanks
Essential oil tanks
Evaporator bodies
Evaporator catchalls
Extractor shells, centrifugal
Filter tanks and drums
Fatty acid equipment
Gelatine storage tanks
Grinding mill bodies
Heads: flanged and formed; elliptical
Heat exchanger bodies
Heavy plate construction
Hoppers
Impregnating equipment
Kiers, peroxide bleaching
Kettles
Linseed oil kettles
Manhole covers and fittings
Mixer bodies
Mixers, jacketed
Nitriding ovens
Oil boiling set kettles
Pans, crystallizing, drying, evaporating
Percolator bodies
Peroxide tanks
Pipe assemblies; large diameter
Phenol storage tanks
Pressure kettles
Rayon desulphurizing equipment
Rendering tanks
Retorts
Resin kettles
Rock salt dissolving tanks
Rolls, large diameter
Rotary dryer shells
Salt dryer bodies
Salt mixers, bodies and hoppers
Settling tanks
Sewage disposal equipment
Sizing drums
Sizing tanks; paper and textile
Soap amalgamators, bodies
Soap boiling kettles
Soap cooling forms
Soap crutcher bodies
Soap storage tanks
Stearic acid tanks
Stills
Storage tanks
Table tops
Tanks
Tank cars
Tomato product equipment
Troughs
Truck tanks
Vacuum kettles
Varnish kettle bottoms
Viscose tanks
Water heater tanks
Water softener storage tanks
Wine tanks

Master Boiler Makers to Meet in September

Plans are progressing rapidly for the holding of the 1936 Business Meeting of the Master Boiler Makers' Association in Chicago, September 16 and 17, at the Hotel Sherman.

A complete program of topic committee reports is now in course of preparation. One of the most important phases of the meeting will be the report of the committee on law, of which Myron C. France, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific, is chairman, and members, Kearn E. Fogerty, Chicago, Burlington & Quincy; L. W. Steeves, C. & E.I.R.R. and William H. Moore, Pére Marquette. The report will incorporate proposed changes to the constitution and by-laws, which have been prepared with a view to setting up an organization along lines which will expedite the handling of convention matters and effect economies.

Technical reports will be presented as follows:

"Boiler and Tender Pitting and Corrosion," prepared by a committee consisting of chairman, J. L. Callahan, general boiler inspector, Chicago Great Western; John P. Bowers, system boiler foreman, Chicago & North Western; and Albert N. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific.

"Autogenous Welding as Applied to Boilers and Tenders," prepared by a committee consisting of chairman, A. F. Stiglmeier, general boiler foreman, New York Central; Sigurd Christopherson, system boiler inspector, New York, New Haven & Hartford; H. H. Service, general boiler inspector, Atchison, Topeka & Santa Fe; G. E. Stevens, boiler supervisor, Boston & Maine; and John A. Doarnberger, general master boiler maker, Norfolk & Western.

"Proper Brick Arch Setting in Locomotive Fire-bricks," prepared by a committee consisting of chairman, E. E. Owens, general boiler inspector, Union Pacific; H. A. Bell, general boiler inspector, Chicago, Burlington & Quincy; B. C. King, general boiler inspector, Northern Pacific; and C. F. Totterer, general boiler foreman, The Alton.

"Proper Thickness of Front Tube Sheet," prepared by a committee consisting of chairman, Walter R. Hedeman, assistant mechanical engineer, Baltimore & Ohio; C. C. Harper, general boiler foreman, Cleveland, Cincinnati, Chicago & St. Louis; E. C. Umlauf, supervisor of boilers, Erie; R. A. Pearson, general boiler inspector, Canadian Pacific.

"Proper Method of Applying all Types of Staybolts," prepared by a committee consisting of chairman, Leonard C. Ruber, supervisor boiler department, The Baldwin Locomotive Works; C. W. Buffington, general master boiler maker, Chesapeake & Ohio; M. V. Milton, general boiler inspector, Canadian Pacific; G. M. Wilson, general boiler inspector, American Locomotive Company.

"Improvements in Locomotive Front Ends," prepared by a committee consisting of chairman, J. M. Stoner, supervisor of boilers, New York Central; H. M. Cooper, district boiler inspector, Baltimore & Ohio; H. E. May, Illinois Central; E. J. Sullivan, supervisor of boilers, Illinois Central; W. C. Hancken, boiler foreman, Atlantic, Birmingham & Coast.

"Topics for 1937 Meeting," prepared by a committee consisting of chairman, G. B. Usherwood, supervisor of boilers, New York Central; W. H. Keiler, locomotive inspector, B. L. I., Interstate Commerce Commission; G. E. Burkholtz, general boiler inspector, St. Louis & Santa Fe; E. H. Gilley, general boiler foreman, Grand Trunk; William Henry, boiler inspector, C.P.R.

Recovery of industry indicated as

Boiler Manufacturers Meet at Skytop

With a determined effort being made by the boiler manufacturing industry to consolidate the gains in production during the past year, members of the American Boiler Manufacturers' Association and Affiliated Industries met at Skytop Lodge, Skytop, Pa., May 31 to June 3 to consider a course of action that will bring about this desirable result.

In his opening address before the general meeting on June 1, attended by about 60 members, associates and guests, President Owsley Brown, of the Springfield Boiler Company, Springfield, Ill., stressed the need for perpetuating the favorable policies developed during the N.R.A. period and subsequently. This industry, after the demise of N.I.R.A., adopted a voluntary code, which, under the able direction of a manager for the industries involved, has functioned to the advantage of all members. Better prices have been obtained for products and price-cutting has been largely eliminated.

Rapidly changing conditions in the legislative situation have created new problems which must be met and regulations for the industry must be brought in line with new requirements. Only by co-operation throughout the boiler manufacturing and affiliated industries can these problems be solved. This is the entire basis on which every element of unfair competition can be eliminated in the future. Mr. Brown concluded with the plea that this spirit of co-operation be the guiding force of the committee meetings which were to follow.

At the general sessions, time was devoted to the presentation of several standing committee reports which follow:

Committee on Boiler Feed-Water Studies

The Joint Research Committee on Boiler Feed-Water Studies is sponsored by the following six organizations: The American Society of Mechanical Engineers; The Edison Electric Institute; The American Railway Engineering Association; The American Water Works Association; The American Society for Testing Materials; The American Boiler Manufacturers Association.

The work of the committee is being carried on under nine sub-committees which are:

Sub-Committee 1.—Coagulation and Sedimentation.

Sub-Committee 2.—Organic Chemicals as Internal Boiler Water Treatment.

Sub-Committee 3.—Foaming and Priming.

Sub-Committee 4.—Electrolytic Prevention of Scale and Corrosion.

Sub-Committee 5.—Corrosion of Boiler and Effect of Treated Water in Accelerating or Relieving Corrosion.

Sub-Committee 6.—Effect of Solution Composition on the Cracking of Boiler Metal.

Sub-Committee 7.—Municipal Water Supplies in Relation to Industrial Use.

Sub-Committee 8.—Standardization of Water Analysis Methods.

Sub-Committee 9.—Review of Patent Literature on the Subject of Boiler Water Treatment.

With the exception of Sub-Committee 6 the work of these committees is at present being carried on at little or no expense to the committee.

Because of the nature and scope of the work being carried on by Sub-Committee 6, special apparatus and expert technicians have been required. Much basic work has been done and a two-year program for the continuation of the work has been laid out. This program entails an expenditure of $7500 a year. Assuming this expense equally divided among the six sponsor organizations an assessment of $1250 from each organization is indicated. An additional sum of $100 is requested from each of the six organizations for general committee expense. This fund will be used principally for the printing and distribution of sub-committee reports.

The report was presented by committee members W. F. Keenan, Jr., and B. J. Cross, representing the American Boiler Manufacturers' Association.

A summary of the current knowledge on caustic embrittlement and a review of the activities of Sub-Committee 6 of the Joint Research Committee on Boiler Feed-Water Studies was presented and will be published in the July issue.

Other reports, all of which were presented by A. G. Weizel, Combustion Engineering Corporation, New York, follow:

A.S.M.E. Boiler Code Conference Committee

In order to keep abreast of the progress being made in the development of pressure vessels and of the materials of which they are constructed, the Boiler Code Committee of the American Society of Mechanical Engineers has made a number of necessary revisions and additions to the various sections of its code. Revisions of material specifications have been made in order to keep up-to-date with the corresponding revisions of the A.S.T.M. material specifications. In some instances, the Boiler Code Committee, after presentation of evidence as to suitability, has approved revised or new material specifications pending adoption by the A.S.T.M. to permit their immediate use. Such action was taken to permit the use of steel containing a range of from 0.25 to 0.60 molybdenum in the high-tensile steels covered by Specifications S-26 and S-27. The use of molybdenum in these steels not only improves their characteristics for forming or working, but is also advantageous from the weldability standpoint.

A special committee has been appointed to prepare revisions to Section VIII of the A.S.M.E. Boiler Code on Unfired Pressure Vessels with the idea of incorporating in the new section the best features of the A.S.M.E. and A.P.I.-A.S.M.E. Code for Unfired Pressure Vessels.

The Boiler Code Committee has adopted for publication, as proposed revisions, the report of its Sub-Committee on Ferrous Materials which covers the allowable stress at elevated temperatures for the various steel plate specifications. In setting the values for the stresses for the various temperatures, the sub-committee was guided by the short time properties of the materials in question, namely, ultimate strength and yield point but at the same time the allowable stress was not permitted to exceed 80 percent of the indicated stress which would cause 1 percent creep in 100,000 hours.

Probably the action during the past year of greatest interest to the boiler industry was the adoption of Case No. 820 which was reported by Mr. Aldrich to all members of the industry on April 22, the day on which it became effective. This case rounds out the allowable pressure values of boiler and superheater tubes by permitting them to be increased to the nearest larger value which is a multiple of ten. It is no longer necessary to stamp a boiler containing 3¼-inch No. 11 gage tubes 199 pounds but the boiler may now be stamped 200 pounds.

The same rounding out applies to other values in the tube tables. The Boiler Code Committee has for a long time had under consideration revisions of the existing tube tables to permit allowable pressures for the various tube gages considerably in excess of those now used. It is not possible to state just when the proposed revisions will be published but probably within the next few months, and on which, when published, the Boiler Code Committee will be glad to have the comments of all interested parties. Publication does not necessarily mean final adoption.

A special committee has been co-operating with safety valve manufacturers on revisions of the safety valve provisions in the boiler code with the idea that revisions will be made to assure the boiler manufacturer, the user, and the inspection services that safety valves stamped with the code symbol will have not less than their stamped discharge relieving capacity. Undoubtedly consideration will also be given to revising minimum required safety valve capacity which at the present time is 6 pounds per square foot on watertube boilers. While it is customary for manufacturers to furnish valves to cover the maximum expected steaming capacity of a boiler including water walls, economizers, etc., it seems desirable to set a higher minimum valve capacity so that ample safety valve discharge capacity will be provided in every case. The U. S. Steamboat Inspection Regulations have minimum required safety valve capacities based on 14 pounds per square foot for watertube boilers and 11 pounds per square foot for firetube boilers, when using oil or pulverized coal as fuel, and 8 pounds for watertube boilers and 6 pounds for firetube boilers when using coal as fuel.

The Boiler Code Committee has, during the past year, reviewed interpretations which it has issued since the first boiler code was adopted in 1914. Most of these interpretations are now unnecessary because they have been incorporated from year to year in revisions to the code. As a result of this study the active interpretations have been reduced from over 800 in number to some 170 in number. Information on this will be published within the next few months and it is hoped that the remaining active cases can be published separately and thereby eliminate inactive references. It is the plan of the Boiler Code Committee to keep the active interpretations down to a minimum by yearly placing, as soon as proper revisions are made to take their place, many on the inactive list.

The Boiler Code Committee is, at all times, glad to receive comments and suggestions from the industry.

National Board of Boiler and Pressure Vessel Inspectors Conference Committee

I have attended a number of the meetings of the executive committee of the National Board of Boiler and Pressure Vessel Inspectors and wish to report that they are carrying on their work in a very creditable fashion. I would like to ask you to read again the very complete and full report made by Carl Myers at our Cleveland meeting, February 20, 1936, in which report Mr. Myers set forth in full detail the reason for the organization of the National Board, the benefits that are available to us and the strong request for the manufacturers to register all of their boilers through the National Board.

Mr. Myers' report also referred to the findings in regard to the deficiency in capacity of safety valves. The committee, after its observation of the work of the National Board and the advantages that can be gained by registering boilers with the National Board and co-operating with their activities, cannot do other than wholeheartedly recommend our close co-operation with them and the registering of all boilers with them.

Undoubtedly the members of our association are also interested in what is happening with the safety valve problem. The National Board has been successful so far in curtailing too hasty action by individual states or municipalities that are members of the National Board.

At the request of the National Board the A.S.M.E. Boiler Code Committee has appointed a special Committee on Safety Valves which committee has held one meeting with the safety valve manufacturers. This meeting was very successful and there was a very splendid feeling of co-operation expressed by the representatives of the safety valve manufacturers and members of the special committee. It is a big problem to be worked out. Nothing definite has been done other than recommending to the Boiler Code Committee that the formula in the appendix of the code for determining safety valve relieving capacities be deleted, which recommendation was accepted by the Boiler Code Committee.

The safety valve manufacturers and members of the special committee seem to be in agreement that safety valve designs should be approved, but the details of how this should be done are still in the making, so that all that we can report on this subject is progress and that no precipitate action is being taken by any of the states or municipalities with the members of the National Board.

There have also been some suggestions as to the revision of Paragraph P-274 in the A.S.M.E. Code which will change the minimum requirements for safety valves.

I wish to advise you that, in my opinion, the National Board has done an excellent job in ironing out many of the difficulties in the administration of the A.S.M.E. Boiler Code in the various states and municipalities and has also, in my opinion, helped in the standardizations of operations between the insurance companies and their inspectors.

American Uniform Boiler Law Society

Since my report to you last year, the code and code movement has made history.

During 1935 some forty odd bills were introduced during the legislative sessions; some of these bills were code bills and others were very detrimental to our industry at large but it is only necessary for me to report that all code legislation was passed and that the bills inimical to the best interests of our industry were defeated.

It is a pleasure to report that among the code bills passed were two of our "general enabling acts," one in the state of Maine and the other in the state of North Carolina—these two states are now full code states and are operating with boiler inspection departments.

While the present year may be called an "off" year in that only about one third of the state legislatures were in session, nevertheless it was a very strenuous year as some ten or twelve bills were introduced that required individual personal attention at the several state capitols. These bills either failed of passage or were vetoed by the governor.

A great deal of time and personal attention has been given to code affairs in the Commonwealth of Massachusetts. The first move was to get the Board of Boiler Rules to authorize the chairman of the board to go over their power boiler rules and amend them in line with the A.S.M.E. Code Rules. After a great many conferences and hours of exacting work, the rules were amended and the amended rules presented to the board for their rejection or approval. The board unanimously approved the revised rules for a public hearing.

The public hearing was held at the State House in the city of Boston in February and was one of the largest hearings, in point of numbers and yet when every one was given the opportunity to be heard, either for or against the proposed revisions, not one word was raised in opposition to the proposed revisions and the hearing went on record unanimously for the revisions.

The next step was the preparation of the revisions, for the final approval of the board and to be passed on to the governor for his rejection or approval. The board approved of the final draft and submitted it to the Commissioner of Public Safety, after which it was placed in the Governor's hands.

The revisions were approved by the Governor as of May 1 and will become law after a period of six months.

We understand that the American Uniform Boiler Law Society will issue in the near future "data sheet No. 5," which will show the status of the code states and cities in so far as they relate to the last code revisions as of July 1, 1935, and the states of Maine, North Carolina and Massachusetts will be added to the list of code states.

Resolution on Government Ownership of Railroads

The following resolution on government ownership and operation of railroads was adopted unanimously by the members of the association:

The members of the A.B.M.A. and Affiliated Industries assembled at the annual meeting June 1, 1936, do hereby express their views and opinions on the subject of government ownership and operation of railroad transportation.

Be it resolved: That it is the opinion of the body that such governmental operation and control would fail to produce economy or efficiency in operation and would by such government ownership, eliminate a source of taxation of a considerable amount, which would force an added burden of taxes in other quarters; and

Be it further resolved, that with the increased volume of business which railroads are now enjoying, together with the general trend of increased prosperity throughout the country, the need of government control and operation is fast disappearing and it is the belief of this organization that these railroads will be able to carry on in the future in a manner satisfactory to both the private investor and the public at large.

Resolutions memorializing the passing of Fred R. Low, former associate of the association and editor emeritus of *Power*, were then presented and placed in the records of the association.

Election of Officers

A. G. Pratt, chairman of the nominating committee, presented the names of those nominated as officers for the coming year. The members present acted on the nominations and the officers elected, as well as those retained as members of the executive committee, follow:

President: Starr H. Barnum, The Bigelow Company,

(*Continued on page 160*)

Work of the A.S.M.E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information on the application of the code is requested to communicate with the secretary of the committee, 29 West 39th St., New York.

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and published.

Following are records of the interpretations of this committee formulated at the meetings of February 28, and March 27, 1936, and approved by the council.

Case No. 817—(*Special Rule*)

Inquiry: When the shells of vessels are fabricated by riveting or brazing but a short distance at the ends of the longitudinal seams, or abutting edges of shells and butt straps, are welded by qualified welding operators, is it the intent of the committee that such vessels shall be classified as welded vessels and stamped with the welding paragraph number as provided in Par. U-66?

Reply: It is the opinion of the committee that if the welding as described is in accordance with the welding requirements of the code for qualified welding operators and the welding at the ends of a longitudinal seam does not extend for a distance greater than $4t$ (t = shell thickness) from the edge of the flange of the head, the vessel need not be stamped with the paragraph number as provided in Par. U-66.

Case No. 819—(*Special Rule*)

Inquiry: Is it permissible, in the manufacture of fusion-welded power-boiler drums, to use steel similar to that covered by Specifications S-26 and S-27, except that the carbon content is limited to 0.25 percent maximum, and molybdenum is added within a range of from 0.25 to 0.60 percent for S-26 steel and 0.40 to 0.60 percent for S-27 steel?

Reply: It is the opinion of the committee that the material specified in the inquiry will meet code requirements when used in the manufacture of fusion-welded boiler drums.

Case No. 820—(*Special Ruling*)

Inquiry: The maximum allowable working pressures permitted by the application of the formulas in Tables P-2, P-3, P-4, and P-5 for thicknesses of boiler and superheater tubes, result in many odd values. May not these values of maximum allowable working pressures be rounded out for practical use?

Reply: It is the opinion of the committee that, in view of the consideration being given to the revision of tube tables, the values of the maximum allowable boiler pressures in pounds per square inch only, resulting from the application of the several formulas for boiler and superheater tubes, may, for actual use, be increased to the nearest larger value which is a multiple of ten.

CASE NO. 821—(*Interpretation of Par. P-302*)

Inquiry: Previous to the last revision of Par. P-302 of the code, it was stipulated that where the pressure exceeded 125 pounds in the steam mains, extra-heavy construction (250 pounds) was to be used. Please explain the revision, also whether it is the intent that 100 pounds was to be the line of demarcation on steam mains as well as blowoffs, and if extra-heavy construction (250 pounds) was to be used when that pressure was exceeded.

Reply: When the code was first written, the only fitting standards were those for 125-pound and 250-pound cast iron—commonly designated as "standard" and "extra-heavy" and so used in the code. The steel-flange standards later adopted and issued were included in the code but without direct reference in the several appropriate paragraphs to their use. The several revisions were made for the purpose of clarifying the use of the cast-iron and steel fittings without changing essentially the use of the cast-iron fittings but eliminating the terms "standard" and "extra-heavy" which are no longer distinctive.

It was the intent of the committee that valves of intermediate standards between 125-pound and 250-pound pressure which have their pressure ratings plainly marked on the valves, may be used for steam service up to their rated capacity and for all feed-line service subject to all restrictions of the code as to temperature and pressure for the particular service.

It was the intent of the code revision to allow the full use of the steel standards listed for steam service at any adjusted pressure-temperature rating given in Table A-10.

The requirement that valves and fittings on water lines below the water line, which includes all boiler feed lines and blow-off service, up to and including the required valve or valves, shall be suitable for pressures 25 percent in excess of the maximum allowable boiler pressure is to make allowance for the actual increased pressure or shock due to temperature conditions in service. The line of demarcation at 100-pound pressure for 125-pound cast-iron fittings for feed line and blow-off services arises from this restriction which was not intended to be applied to steam mains.

CASE NO. 822 (*In the hands of the Committee*)

CASE NO. 823 (*Special Ruling*)

Inquiry: Is it permissible, in the construction of low-pressure heating boilers, to use a dished head, having no knuckle flange, secured to the shell by a corner weld? Also, what rule must be followed in making the welded-head attachment?

Reply: It is the opinion of the committee that this construction may be used provided the welding of the head to the shell conforms to Par. H-78, except that hot-water boilers and boilers built for domestic water supply above 30-pound pressure shall be constructed with flanged heads.

Trend of Locomotive Boiler Design

By G. P. Blackall

A typical modern locomotive may be taken as having three driving axles, each carrying a weight approximately 20 tons, or 60 tons in all, and this, being sufficient weight for effective adhesion for the loads and speeds required, is the total useful weight of the locomotive. The total weight, however, including the tender, coal, and water, may be as much as 160 tons, giving an extra load of 100 tons which has to be hauled by the engine and must be added to the gross weight of the train. In an interesting paper on locomotive design delivered recently by J. W. Beaumont before the Institution of Locomotive Engineers, London, it was argued that the reduction of this extra load is the great problem before the locomotive designing engineer of today. Mr. Beaumont went on to survey the various sections of a locomotive with a view to seeing where a reduction in weight might possibly be effected.

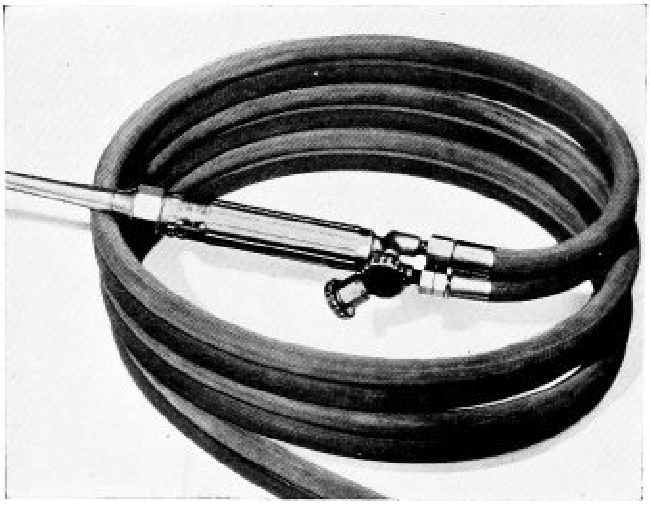
Dealing with the boiler, Mr. Beaumont said that the ordinary locomotive boiler, with its fire tubes and blast pipe, is, with its modern improvements, still a highly efficient apparatus for its purpose. However, it seems to be getting very near its limit as regards steam pressures, and higher pressures may well be one of the most important factors in future progress. The most likely substitutes appear to be either the water tube boiler or the unitubular steam generator. The water tube boiler is now commonly constructed for pressures of 700 or 800 pounds, and, particularly for marine work, has been made of very compact design, though perhaps its fullest efficiency is reached where size and shape are not of so much importance. It is capable of producing steam on a lower rate of fuel consumption than the locomotive boiler, and has a good storage capacity.

Steam generators of the unitubular type, although it is now a good many years since they were first used, have not as yet been built to a capacity which would be required for a full-sized locomotive. They are still of comparatively small power, but producing steam at very high pressures, fired either with solid or liquid fuel, and on a fuel consumption substantially lower than on any ordinary type of boiler. Railcars fitted with this generator, built by the Henschel concern, are now operating in Germany, while a shunting locomotive built in Britain by the Sentinel Waggon Works, is running on the London, Midland & Scottish Railway.

Mr. Beaumont sees no reason why the principle should not now be extended to much larger generators, used either singly or in multiple units. Until quite recently these generators had only been fitted for firing with oil or other liquid fuel, but now both Siemens in Germany and Doble in the United Kingdom have successfully overcome the solid fuel difficulty and the coal or coke-fired generator is now available. Mr. Beaumont is convinced that there is scope for much ingenuity in the adaptation of this method of steam generation to the most powerful of modern locomotives, and declares that its success would in itself go far to solve the weight problem.

Duplex Hose for Gas Welding

A type of rubber tubing or hose of unique construction has been developed by the Electric Hose and Rubber Company, Wilmington, Del. It is especially designed for gas welding and cutting equipment and similar services. In its construction twin hose are simultaneously molded with a connecting web between them, so that a cross-section resembles the figure 8. A single length of this non-kinking hose is all that is necessary for equip-



Supero Siameez duplex hose for gas welding work

ment which heretofore has required two separate lengths. This hose is of Supero construction, with a special cord-wound reinforcement between the first and second braid, giving it a much higher bursting limit than ordinary welding tubing—with the ¼-inch size the bursting pressure is 2000 pounds per square inch. This construction permits the use of differing pressures in the two sides without torque or writhing.

Supero Siameez hose is made with the individual conduits in different colors—red and black or red and green, for example—or with both the same color. The connecting web may be easily cut down with a carborundum wheel the distance required for attaching the hose to separate outlets.

Boiler Manufacturers Meet at Skytop

(Continued from page 158)

New Haven, Conn.

Vice-President: W. F. Keenan, Jr., Foster Wheeler Corporation, New York.

Secretary-Treasurer: A. C. Baker, 709 Rockefeller Building, Cleveland, O.

Executive Committee (three years): A. W. Strong, Jr., The Strong Scott Manufacturing Company, Minneapolis, Minn.; R. J. Bros, William Bros Boiler & Manufacturing Company, Minneapolis, Minn.; E. R. Stone, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. (Two years): E. E. Knoblock, Union Iron Works, Erie, Pa.; A. G. Weigel, Combustion Engineering Corporation, New York; J. F. Dillon, Jr., Struthers-Wells-Titusville Corporation, Warren, Pa. (One year): F. H. Daniels, Riley Stoker Corporation, Worcester, Mass.; M. E. Finck, Murray Iron Works, Burlington, Ia.; A. G. Pratt, Babcock & Wilcox Company, New York. (Ex-Officio): Starr H. Barnum, The Bigelow Company, New Haven, Conn.; Walter F. Keenan, Jr., Foster Wheeler Corporation, New York.

The remaining two days of the meeting were devoted to special sessions of the various branches of the association and industry, including the Horizontal Return Tubular Branch, H. E. Aldrich, chairman; A. B. M. A. associate members, D. Robert Yarnall, chairman; Stoker Branch, E. R. Stone, chairman; Superheater Branch, Air Preheater and Economizer Branch, J. D. Andrew, chairman; Pulverizer Branch, A. W. Strong, chairman, and the Watertube Boiler Branch, J. D. Andrew, chairman.

The annual banquet was held at Skytop Lodge, the evening of June 2. Golf tournaments for members and associates were conducted afternoons during the sojourn at Skytop.

Registration at A.B.M.A. Meeting

Aldrich, H. E., Office of A.B.M.A., 15 Park Row, New York.
Anderson, E. L., Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.
Andrew, J. D., Office of A.B.M.A., 15 Park Row, New York.
Baker, A. C., Secretary, A.B.M.A., 709 Rockefeller Building, Cleveland, O.
Barnum, G. S., The Bigelow Company, New Haven, Conn.
Barnum, S. H., The Bigelow Company, New Haven, Conn.
Bateman, W. H. S., Detroit Seamless Steel Tubes Company, Philadelphia, Pa.
Blodgett, L. S., Boiler Maker and Plate Fabricator, New York.
Bros, R. J., Wm. Bros Boiler & Manufacturing Company, Minneapolis, Minn.
Brown, J. R., Reliance Gauge Column Company, Cleveland, O.
Brown, Owsley, Springfield Boiler Company, Springfield, Ill.
Carson, W. S., Globe Steel Tubes Company, Milwaukee, Wis.
Champion, T. P., The Champion Rivet Company, Cleveland, O.
Chipman, F. W., International Engineering Company, Framingham, Mass.
Coburn, J. F., J. F. Corlett & Company, Cleveland, O.
Conlon, W. T., The Superheater Company, New York.
Connelly, W. C., Cleveland, O.
Daniels, C. M., Bethlehem Steel Company, Bethlehem, Pa.
Daniels, F. H., Riley Stoker Corporation, Worcester, Mass.
Davis, G. L., Diamond Power Specialty Company, Detroit, Mich.
De Windt, J. P. H., National Bureau of Casualty and Surety Underwriters, New York, N. Y.
Eury, J. G., Henry Vogt Machine Company, Louisville, Ky.
Felker, G. F., Crosby Steam Gauge & Valve Company, Charlestown, Mass.
Ferguson, Wm., Travelers Indemnity Company, Hartford, Conn.
Fish, E. R., Hartford Steam Boiler Inspection & Insurance Company, Hartford, Conn.
Fleming, H. H., Johnston & Jennings Company, Cleveland, O.
Foresman, R. A., Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.
Gordon, F. H., Lukens Steel Company, Coatesville, Pa.
Gorton, C. E., American Uniform Boiler Law Society, New York.
Hess, D. C., Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.
Hobbs, C. H., Detroit Seamless Steel Tubes Company, Detroit, Mich.
Humpton, W. J., Lukens Steel Company, Coatesville, Pa.
Huyette, P. B., Paul B. Huyette Company, Philadelphia, Pa.
Huyette, S. L., Paul B. Huyette Company, Philadelphia, Pa.
Jones, E. A., Bethlehem Steel Company, Bethlehem, Pa.
Keenan, W. F., Jr., Foster Wheeler Corporation, New York.
Knoblock, E. E., Union Iron Works, Erie, Pa.
Knoblock, E. T., Union Iron Works, Erie, Pa.
Lally, R. R., Globe Steel Tubes Company, Milwaukee, Wis.
Lumbard, Warner, Boiler Maker and Plate Fabricator, New York.
McCreight, W. N., Vulcan Soot Blower, Corporation, DuBois, Pa.
Mildon, R. B., Westinghouse Electric & Manufacturing Company, Philadelphia, Pa.
Myers, C. O., Secretary, National Board of Boiler and Pressure Vessel Inspectors, Columbus, O.
Obert, C. W., Union Carbide & Chemical Corporation, New York.
Pool, Ira J., National Tube Company, Pittsburgh, Pa.
Pratt, A. G., Babcock & Wilcox Company, New York.
Royer, D. L., Ocean Accident & Guarantee Corporation, New York.
Sampson, W. J., Jr., Steel & Tubes, Inc., Cleveland, O
Simon, E. F., Ohio Machine & Boiler Company, Cleveland, O.
Stone, E. R., Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa.
Strickland, O. I., Wheeling Steel Corporation, Wheeling, W. Va.
Strong, A. W., Sr., The Strong-Scott Manufacturing Company, Minneapolis, Minn.
Strong, A. W., Jr., The Strong-Scott Manufacturing Company, Minneapolis, Minn.
Swain, P. W., *Power*, New York.
Thomas, W. P., Diamond Power Specialty Company, Detroit, Mich.
Tudor, M. J., Tudor Manufacturing Company, Cincinnati, O.
Weigel, A. C., Combustion Engineering Corporation, New York.
Wood, S. C., Wheeling Steel Corporation, Wheeling, W. Va.
Worker, J. G., American Engineering Company, Philadelphia, Pa.
Yarnall, D. R., Yarnall Waring Company, Chestnut Hill, Pa.

Lincoln Electric Changes Sales Force

The Lincoln Electric Company announces the following changes and promotions in its sales personnel.

J. S. McKeighan has been transferred to the sales staff and is stationed at 1712 Catalpa Drive, Dayton, O., operating under the Cincinnati District Office, located at 5th and Baymiller Streets.

J. B. McCormick has been transferred from the Philadelphia office, 401 North Broad Street to the Pacific Coast, and is stationed at 3160 Montecito Avenue, Fresno, Cal., under the personnel of the Los Angeles office at 812 Mateo Street.

Paul W. James has been transferred from the factory to 16½ Crandall Street, Binghamton, N. Y., operating under the Syracuse office, at 517 Erie Boulevard, East.

The Major Engineering Works has moved its offices from 210 Jackson Avenue to larger and more conveniently located quarters at 312 Second Street, Des Moines, Ia.

New Secretary of Allegheny Steel Appointed

The appointment of Edward J. Hanley, assistant superintendent of the wire and cable department of the Schenectady Works of the General Electric Company, as secretary of the Allegheny Steel Company has been announced, effective upon his reporting for his new duties at Brackenridge, Pa., on May 25, 1936. Mr. Hanley, a native of Whitman, Mass., was graduated from Phillips Andover Academy in 1920 and obtained a B. S. from Massachusetts Institute of Technology in 1924 and in 1927 a master's degree in business administration from the Harvard graduate school of business.

Crossfield Welder Lowers Cost 10 Percent

Comparative welding cost for fabrication of two identical pieces of machinery in regular shop production showed a 10 percent saving in overall welding cost using the new "crossfield" type welder as compared with the cost for conventional types. The usual 50 percent of the total welding cost for labor was reduced 13½ percent and the 40 percent formerly expended for electrodes was reduced 9 percent resulting in a 10 percent reduction of overall welding cost.

Detailed results of the operating comparison between the new series 400-ampere Flexarc welder and their superseded 400-ampere welder follow:

	New Flexarc Machine	Conventional Type Machine
(1) Current	340 amperes	340 amperes
(2) Deposit Efficiency of Electrode.....	72.3 percent	66.1 percent
(3) Metal Melted per Hour	12.16 pounds	11.7 pounds
(4) Metal Deposited per Hour	8.79 pounds	7.74 pounds

Westinghouse ¼-inch diameter "Crucible Weld" downhand electrodes were used in this test, and all welding was done by the same welding operator under identical conditions.

Recent Republic Steel Sales Appointments

The New York district sales office of the Republic Steel Corporation has opened a new sub office in the State Bank Building, Albany, N. Y., with J. M. Higinbotham salesman in charge.

L. L. Caskey has been appointed district sales manager for Republic Steel Corporation in the Philadelphia territory, according to an announcement by N. J. Clarke, vice-president in charge of sales.

J. B. DeWolfe whom Mr. Caskey succeeds, has been transferred to the general offices in Cleveland to assist George E. Totten, manager of sales of the tin plate division.

J. W. Braffett, for the past seven years Detroit representative of the Oliver Iron and Steel Corporation, has joined the Detroit sales staff of Republic Steel Corporation, Upson Nut division, located in the Fisher Building, according to an announcement by C. F. Newpher, sales manager of that division. Mr. Braffett is a graduate of the mechanical engineering school of Cornell University and has had a varied career as sales engineer. During the war he was test supervisor of Liberty engines in the Bureau of Aircraft Production and with the signing of the Armistice began a long career with the Ternstedt Manufacturing Company of Detroit. Soon after leaving that organization he became associated with Oliver Iron and Steel Corporation.

Julius Kahn, who has been president since his founding of Truscon Steel Corporation 33 years ago, has resigned his position to become vice-president in charge of product development of Republic Steel Corporation, Cleveland, O.

Forrest H. Ramage has been promoted from assistant manager of the advertising and sales promotion division to sales promotion manager and will work in conjunction with the new product development division.

Stanley A. Knisely, formerly manager of the advertising and sales promotion division, has been named director of advertising with direct supervision of all advertising of the Corporation and its subsidiaries. Chester W. Ruth has been made assistant director of advertising.

National Tube Elects New Vice-President

C. R. Cox, formerly general superintendent of Ellwood Works of National Tube Company, was, on May 12th, elected vice-president in charge of engineering and operations of said company, succeeding P. C. Patterson, who was associated with the Tube Company for forty-nine years and who has been, since 1926, vice-president in charge of engineering and operations.

Mr. Patterson attended the University of Pittsburgh and entered the employ of National Tube Works Company at McKeesport in 1886. He later became draftsman, foreman and then superintendent of the lapweld department. In 1900 he was appointed chief engineer of the Tube Company, in 1922 assistant vice-president in charge of operations, and in 1926 was elected vice-president.

Mr. Cox was graduated from New York University in 1914, and in 1918 became identified with United States Shipping Board Emergency Fleet Corporation. In 1920 he entered the employ of Pittsburgh Crucible Steel Company at Midland, Pa., in 1925 became superintendent and in 1927 manager of Park Works of Crucible Steel. In 1930 he was appointed superintendent of the Babcock & Wilcox Tube Company plant at Beaver Falls, Pa. In 1934 he was appointed assistant general superintendent and in 1935 general superintendent of Ellwood Works of National Tube Company. Mr. Cox's office will be in Pittsburgh.

National Power Show in December

The management of the National Exposition of Power and Mechanical Engineering has announced that the 12th Exposition will be held from November 30 to December 5 inclusive, coincident with the annual meeting of the American Society of Mechanical Engineers.

The exposition this year is expected to be more comprehensive than in the past. The improvement in business will be one influence, and the great interest which manufacturers have developed in their products through research, developing new products and improvements on standard products will make the exposition very interesting. There will be large and heavy equipment, from equipment used in the generation of power, its distribution and utilization through mechanical equipment for handling materials, tools and various other mechanical devices. There will be the usual large grouping of refractories, stokers, burners and fuel burning equipment of various types, boilers and power generating equipment, engines, pumps and steam equipment, piping, valves, fittings, showing all the recent developments in these lines, and supplies used coincidental thereto, instruments of precision for control and measurement of volume, speed, rate of flow, pressure, time and other numerous factors which must be known in industrial operations. There will be the whole range of material supplies, lubricants, packing, belting and other incidental products, tools and machine tools, etc.

The management now reports that over 100 of the former exhibitors have already reserved space and applications are being received daily, that approximately 1½ floors of the great Grand Central Palace have already been engaged and it is expected that three floors will this year be used for the exposition.

Pipe Line Construction Active

Oil and gas pipe line activity, which has been increasing rapidly in the last several months, has reached again into Western Kansas and Indiana. The Continental Oil Company has just completed contracts with Williams Brothers Construction Company to lay a new 79-mile oxy-acetylene welded line in Kansas and the sub-contract for welding has been awarded to the Osage Construction Company. The multi-flame Lindewelding process will be employed. Sixty-five miles of the line will be 8-inch and 14 miles will be 6-inch pipe. New pipe in 40-foot lengths will be used and work is scheduled to start during the early part of May.

A contract for a new oxy-acetylene welded natural gas line to run between Terre Haute and Montezuma, Ind., has just been awarded by the Kentucky Natural Gas Corporation to Connor and Sons Construction Company, Kansas City. This will be a 24-mile line of 12-inch pipe multi-flame welded throughout. New pipe of 0.259-inch wall thickness and in 20-foot random lengths will be used.

Communication

New Design in Stud Drivers

To the Editor:

The drawing and a description of a stay or stud driver will I think be of interest to the readers of the Boiler Maker and Plate Fabricator.

Various methods are employed for the driving of stays and studs, but the device shown in the accompanying sketch does this work in a very efficient manner. The device consists of a split component A which is held together by set screw C and dowel B. The washer F is a filling piece for the counter bore, necessary in screwing the portion A to receive the stay or stud. The depth of the threaded portion is governed by the amount of stay that is required through the plate for riveting or nutting.

To utilize this tool the component A is placed in the socket G which has a driving pin H through which the load is transmitted. The socket A is made to suit whatever motor there is at the disposal of the user. The usual type of socket is a No. 3 Morse.

The stays or stud are placed in the component A which is screwed as mentioned previously. It is then driven through the plates and when home the machine is drawn backwards thus leaving the A portion on the stay which can be taken off quite easily by reason of it being split and hinged. This obviates the usual reversing of the motor and pulling the stays out again.

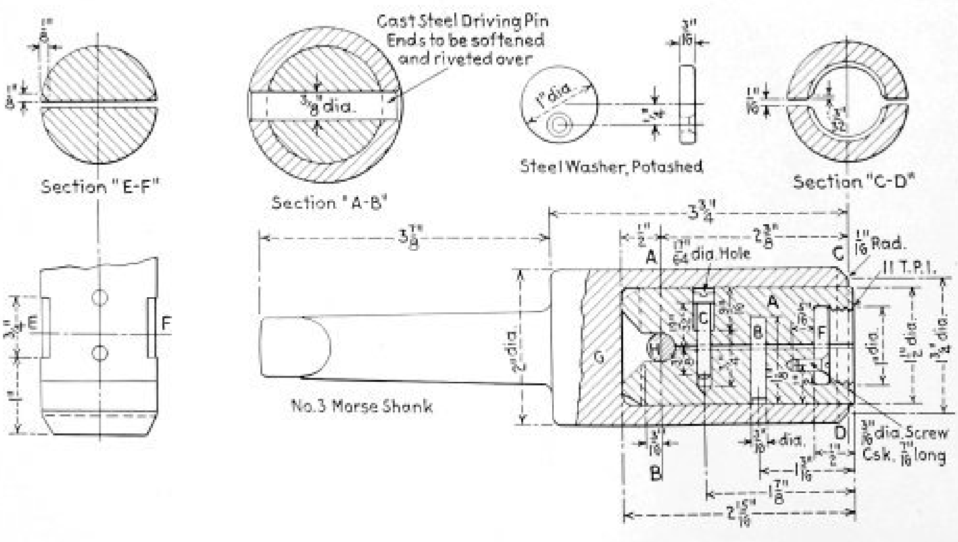
Crewe, Eng. J. W. Thompson

Trade Publications

A. C. Motors.—Information on the price, overall dimensions, capacities and operating characteristics of the full line of general purpose squirrel cage induction motors is included in a pamphlet issued recently by the Lincoln Electric Company, Cleveland.

Industrial Lighting.—In the interests of better lighting conditions in factories, manufacturing plants and other industrial structures, the General Electric Company, Schenectady, N. Y., has prepared a bulletin on the problems of better lighting and suggestions on the proper selection of lamps recently developed for specific industrial applications.

Insulating Firebrick.—A complete description of the properties, sizes, uses and limitations of five different types of insulating firebrick for the use of furnace lining, has been recently brought together in a bulletin prepared by the Babcock and Wilcox Company, New York. In addition, illustrations are included of the installation of such firebrick and discussions on various problems of furnace brick work.



Details for constructing a stay or stud driver with removable holder

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

VOLUME XXXVI NUMBER 6

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EDITORIAL STAFF: H. H. Brown, Editor. L. S. Blodgett, Managing Editor. H. W. MacDonald, Associate Editor.

BUSINESS MANAGER: Warner Lumbard.

Contents

FORGED STEEL VALVES.—A catalogue on the complete line of Hancock forged steel valves for all steam pressure ranges up to 1500 pounds per square inch has just been published by the Hancock Valve Division of the Consolidated Ashcroft Hancock Company, Inc., Bridgeport, Conn. A number of distinctive features are claimed by the makers of these valves that are to reduce valve replacement and maintenance costs.

VANADIUM STEEL.—The Vanadium Corporation of America, manufacturer of ferro-vanadium, ferro-chromium, ferro-silicon and other alloys of that order, has prepared a pamphlet on some of the recent applications and uses of Vanadium steels among which are building pile drills, firearm parts, machine tool sections, together with a short description on the welding characteristics of manganese Vanadium steel. There are available at the same time, sections 10A, 11A and 12A of prepared specifications on manganese Vanadium forged billets, on axles, shafts and other forgings and on locomotive castings.

COMBUSTION RECORDERS.—A new catalogue giving description and discussion of the advantages, operation and installation of combustion recorders has been published by the Hays Corporation, Michigan City, Ind., manufacturers of industrial instruments and apparatus. The catalogue is fully illustrated and describes in complete detail the recorders that give continuous data on CO_2 and draft ratings and flue-gas temperatures.

STAINLESS STEELS.—The wide application of stainless steels, from cooking and heating utensils and small decorative devices, through all kinds of industrial machinery to heavy transportation equipment is brought out in a booklet prepared by the Ludlum Steel Company, Watervliet, N. Y., makers of tool steels, stainless and other alloy steels. The bulletin is fully illustrated and description is given of the advantages of this comparatively new material.

TONCAN IRON PIPE.—The fourth edition of "Toncan Iron Pipe for Permanence" is being currently distributed by Republic Steel Corporation, Cleveland. This 64-page book is profusely illustrated with test charts and tables and incorporates new sections dealing with threading, air conditioning, industrial maintenance and process uses, etc. In addition is a long list of photographs showing the increasing applications for which this type of pipe is being utilized.

RIVETING HAMMERS.—A four-page special bulletin, No. 1946, recently prepared by the Chicago Pneumatic Tool Company, New York, gives complete details of a new development that has been made in the design of Boyer air-cooled riveting hammers. Cross-sectional illustrations of the tool are shown, together with a brief discussion of the advantages of using the air-cooled hammer. A table of specifications is also presented of the complete line of both the standard long-stroke hammer and the special heavy Boyer hammer.

JIGS AND FIXTURES.—The Lincoln Electric Company, Cleveland, manufacturers of arc welding equipment, has prepared a guide to lower tooling costs, with the use of shielded-arc welded steel jigs and fixtures. This guide contains description and discussion of tooling problems and the extensive use of welding that might be made in these operations. Specific illustrations are given of the economy effected, together with photographs of welded jigs and fixtures.

POWER SQUARING SHEARS.—The Niagara Machine and Tool Works, manufacturer of machines for plate and sheet material work, Buffalo, N. Y., has recently prepared a bulletin designated No. 71-F. This bulletin deals with the series BL-100-500-10 types of power squaring shears in various gage capacities. The publication is fully illustrated and presents complete dimensions and capacities of each of the various machines in question. In addition, some discussion is devoted to certain appliances with which these shears are equipped.

CHROMIUM STEEL CUTTING AND WELDING.—A booklet on the subject of cutting and welding high chromium steels has been prepared by the Linde Air Products Company, New York. The booklet presents the latest information on the subject and the effect of chromium on welding procedures is discussed and the recommended techniques for welding the various types of high chromium steels are presented. Emphasis is placed on the recent discovery of the improved welding characteristics which result from additions of columbium to both base metal and welding rod. Oxy-acetylene cutting of high chromium steel is also discussed together with the recommended practice for accomplishing this work.

Questions and Answers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Boiler Tube Life

Q.—How is the life of a locomotive boiler tube usually determined? J. S.

A.—The Interstate Commerce Commission Bureau of Locomotive Inspection, Laws, Rules and Instructions for inspection and testing of steam locomotives and tenders and their appurtenances, Rule 10, states:

Flues to be removed—All flues of boilers in service, except otherwise provided, shall be removed at least once every four years, and a thorough examination shall be made of the entire interior of the boiler. After flues are taken out the inside of the boiler must have the scale removed and be thoroughly cleaned. This period for the removal of flues may be extended upon application if an investigation shows that conditions warrant it. When tubes are removed from the boiler they should be examined for surface defects and so far as possible shall be free from depressions caused by scale or scoring.

The tubes deteriorate more rapidly at the ends toward the fire, and they should be carefully tapped with a light hammer on their outer surface to ascertain whether there has been a serious reduction in thickness. The condemning limit of tubes is usually determined by weight. This weight varies somewhat at the different shops, the weights given below being an average.

Tubes and flues are to be weighed and those meeting weight, shown in the following table, are to be welded and used on any locomotive.

Outer Diam. Inches	Nearest B.W.G.	Decimal Thickness B.W. Gage—Inches	Minimum Weight Pounds per Foot
1¾	12	0.109	1.57
1¾	11	0.120	1.57
2	12	0.109	2.05
2	11	0.120	2.05
2¼	12	0.109	2.31
2¼	11	0.120	2.31
2½	12	0.109	2.56
2½	11	0.120	2.56
3¼	11	0.120	3.56
3¼	10	0.134	3.56
3½	12	0.109	3.66
3½	11	0.120	3.66
5⅜	9	0.148	7.51
5½	9	0.148	7.75

Welding Large Storage Tanks

Q.—I want to build some storage tanks 48 feet diameter, 30 feet high. I will arc-weld the entire tank, using the A. P. I. code, but I find very little relating to welding shell plates. I have thought of lap welding all seams, dropping the bottom edge of the second course inside the top edge of the first course 1 inch, and so on. I would be very much pleased to receive any information you might have about welding shell plate either butt or lap. W. N. S.

A.—The "Welding Encyclopedia" published by the Welding Engineer Publishing Company, Chicago, Ill., includes the "Report of the Committee for the Electric Welding of Storage Tanks of the American Welding Society."

This report is too long to publish in the space allotted to this department. You could, however, obtain a copy of same by writing the American Welding Society or obtaining a copy of the "Welding Encyclopedia."

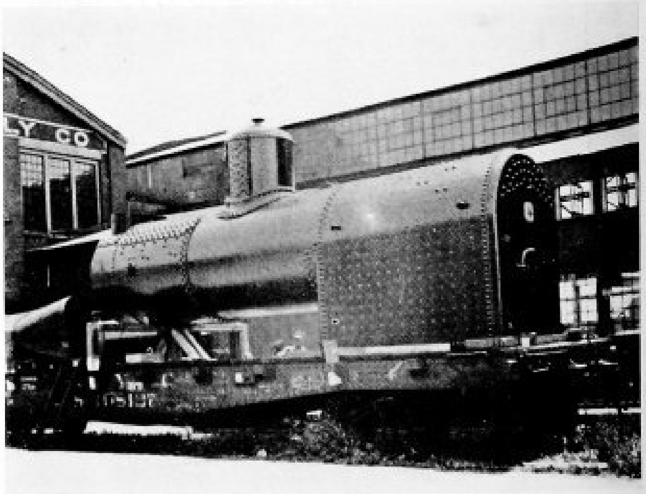
The report includes a detailed description of the method of welding and constructing a 5000-barrel tank, approximately 44 feet in diameter and 25 feet high, which compares favorably to the tank as outlined in the question.

In answer to your question on the lap, the report states that the lap should be six times the thickness of the plate.

Modern Boiler Construction and Design

Q.—We are interested in obtaining up-to-date information descriptive of modern boiler design and construction practices. We should be pleased to have you recommend several texts, keeping in mind that we manufacture only locomotive type oil country firetube boilers. These boilers are built in sizes up to 125 horsepower, with 84-inch firebox, and for 350 pounds steam working pressure. We would also be interested in knowing if you are familiar with any reliable tests on this type of boiler which would indicate the ratio of heat absorbed in the firebox and in the tubes. The tests on railroad locomotive boilers should, in general, indicate what might be expected in the locomotive oil country type boiler. Any information that you can supply along these lines will be greatly appreciated.—D. M. H.

A.—There are but few books giving up-to-date information descriptive of modern boiler design and construction practices; most of this information can only be obtained from articles in the various engineering publications, which keep the reader fully informed on all the latest developments both in design and construction.



Typical oil country boiler

Several texts that could be recommended are as follows:

(1) For rules and formulas covering boiler calculations:

The A.S.M.E. Boiler Code, published by the American Society of Mechanical Engineers, 29 West 39th Street, New York.

(2) For basic design and theory of constructional details:

"Design of Steam Boilers and Pressure Vessels," by Haven and Swett, published by John Wiley & Sons, Inc., New York.

(3) A practical locomotive boiler book:

"A Study of the Locomotive Boiler," by Lawford H. Fry, published by the Simmons-Boardman Publishing Company, New York.

(4) For the development of the plates of a locomotive boiler:

"Laying Out for Boiler Makers," published by the Simmons-Boardman Publishing Company, New York.

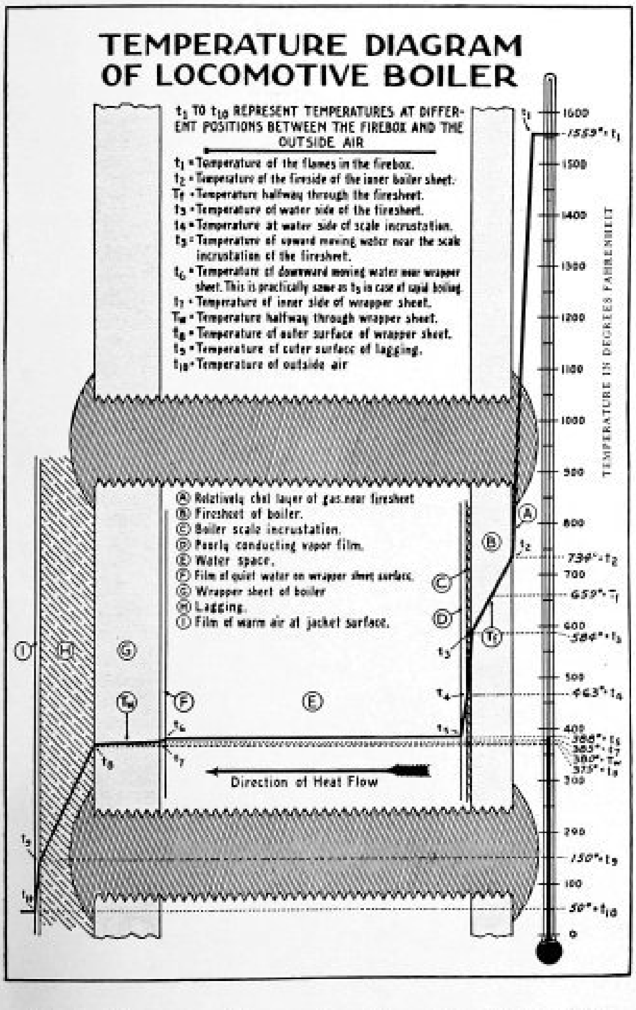


Fig. 1. Temperature diagram of waterleg in locomotive boiler

In connection with the ratio of heat absorbed in the firebox, Fig. 1 shows the results obtained by placing thermocouples in the waterleg of a locomotive boiler about half way between the fire zone and the brick arch. The temperatures were measured while the engine was in service. You will notice on this chart that t^2, the temperature of the fireside of the inner boiler sheet, is 734° F., while t^3, the temperature of the water side of the fire sheet, is 584° F., a drop of 150 degrees F. through the plate or one-fifth of the heat is used in passing through the plate.

From the evaporative values of tubes, flues and firebox for locomotive boilers as given by Coles ratios, which were obtained by extending the Coatesville evaporation tests beyond the figures obtained when the firebox and tube evaporation were taken separately, 9.97 pounds of water evaporated per hour per square foot of outside tube heating surface, and 54.8 pounds per hour per square foot of firebox heating surface were obtained. These, for the sake of eliminating unimportant fractions, were taken at 10 pounds per tube heating surface and 55 pounds for firebox heating surface.

The best available data shows that the evaporative value of tubes or flues varies with the difference in length, diameter and spacing. The rate of evaporation on this basis will vary directly as the difference of temperature of the gases passing through the tubes and flues and that of the steam contained in the boiler. The base figure taken is 10 pounds of water per hour per square foot of outside heating surface of 2¼-inch tubes 18 feet long.

Plate Development and Layout Problems

Q.—I am interested in the series of plate development and layout problems written by you and appearing in the BOILER MAKER AND PLATE FABRICATOR. I would like to have a copy of this work in separate form. Do you have such a copy, and how could I get it? F. W. G.

A.—The series of plate developments and layout problems appearing in the BOILER MAKER AND PLATE FABRICATOR is not printed in separate forms; I can only advise you to bind the series into a book after same is completed.

If you are interested in plate development and layout work, the book "Laying Out for Boiler Makers" includes many layouts problems of a similar nature as those published in the series, together with a vast amount of practical knowledge. This book is published by the Simmons-Boardman Publishing Company, 30 Church Street, New York.

Collapsible Hand Tap

A hand sizing tap of the collapsible type designed primarily to take the place of the solid adjustable taps ordinarily used has been added to the line of machine collapsible taps manufactured by the Landis Machine Company, Waynesboro, Pa. These taps offer the advantage of instant withdrawal from the work without requiring to be backed out. They also eliminate the tearing of threads, frequently caused by backing out a solid tap, as well as undue wear of the chasers by having the radial clearance worn off in the backing-out operation. Tapping time is, of course, saved, thereby increasing production.

A small handle or trigger is located on the side of the tap body for unlatching the tap and collapsing the chasers by pressing back on the handle. The chasers are reset by pressing against a plunger extending slightly beyond the rear of the tap shank. The tap shank is provided with a square end to fit a tap wrench. Any length of shank or tap can be supplied.

The top is provided with a diametrical adjustment of approximately $\frac{1}{32}$ inch both over and under the nominal chaser size, a total of $\frac{1}{16}$ inch. The adjusting screw is located in the front end of the tap and is of the ratchet type, making it self-locking to maintain size. A turn of one notch to the adjusting screw gives a diametrical movement of the chasers amounting to 0.001 inch, an important feature for hand sizing work. These taps can be furnished in all sizes from 1⅜ inches to 12 inches, inclusive.

Associations

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Assistant Chief Inspector—J. A. Shirley, Washington.
Assistant Chief Inspector—J. B. Brown, Washington.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Director—Joseph B. Weaver, Washington, D. C.

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Assistant International President—J. N. Davis, Suite 522, Brotherhood Block, Kansas City, Kansas.
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Office of Industrial Recovery Committee,
15 Park Row, New York

Manager—James D. Andrew.
Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President — Merle J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

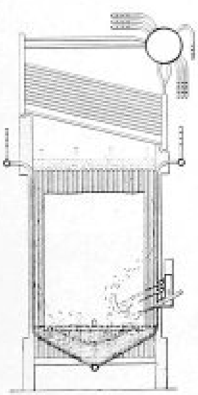
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,866,404. FINELY DIVIDED FUEL BURNING FURNACE. MARTIN FRISCH, OF NEW YORK, N. Y., AND ERIC LUNDGREN, OF FREDERICK, MARYLAND, ASSIGNORS TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

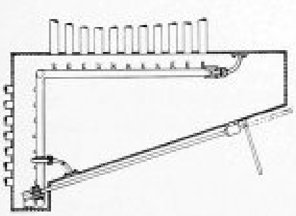
Claim.—In a pulverized fuel fired furnace, the combination of a combustion chamber, steam evaporating tubes largely defining said chamber



and including relatively closely spaced steam evaporating tubes defining a bottom for the chamber constructed and arranged to retain a stagnant bed of slag, means for introducing the fuel with carrying air into said chamber, and air nozzles for introducing additional air into the chamber, said fuel introducing means being directed toward the bed of slag retained in the bottom of the chamber. Twenty-two claims.

1,865,080. SOOT BLOWER. FRANK BOWERS, OF DETROIT, MICHIGAN, ASSIGNOR, BY MESNE ASSIGNMENTS, TO DIAMOND POWER SPECIALTY CORPORATION, OF DETROIT, MICHIGAN, A CORPORATION OF MICHIGAN.

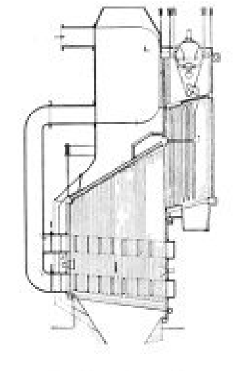
Claim.—In a boiler cleaner, the combination with a blower movable transversely of rows of boiler tubes for cleaning the same, of step by



step mechanism for actuating said blower by advancing the latter each step from registration with one row of said tubes into registration with the next adjacent row, an oscillatory actuating handle for said blower, and means automatically reversing the travel of the blower by operation of said handle subsequent to a predetermined travel of the blower. Twenty-six claims.

1,885,071. STEAM GENERATOR. HANS J. E. BANCK, OF SPRINGFIELD, ILLINOIS, ASSIGNOR TO SPRINGFIELD BOILER CO., OF SPRINGFIELD, ILLINOIS, A CORPORATION OF ILLINOIS.

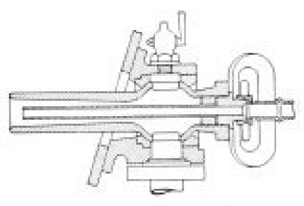
Claim.—In a steam generator adapted for operation at ratings greatly in excess of its nominal rating, the combination with vertically disposed water tubes arranged to absorb radiant heat from the combustion chamber of the generator in amount sufficient to generate the major portion of the steam generated, steam and water separating means located at a level substantially above the heat absorbing portions of said tubes including a steam receiving means and conduit connections between the last mentioned means and said tubes arranged to restrict the escape of steam and water into said receiving means from said water tubes and to return to the upper ends of the latter much of the water entering said connections from said tubes, and separate water return connections extending from said receiving means to the lower ends of said tubes and located out of heat absorbing relation



with said chamber whereby said heat absorbing tube portions are normally filled with water under an appreciable hydraulic head. Eleven claims.

1,867,101. CLEANING DEVICE FOR PULVERIZED FUEL FURNACES. RICHARD ROOSEN, OF KASSEL, GERMANY, ASSIGNOR TO STUG KOHLENSTAUBFEUERERUNG PATENTVERWERTUNG G. M. B., OF KASSEL, GERMANY.

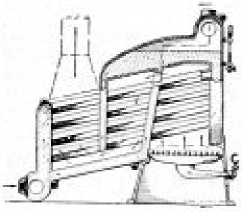
Claim.—A cleaning device for pulverized fuel furnaces comprising a steam nozzle mounted by means of a ball joint in front of and projecting into a hole in the fire door of the furnace, another nozzle con-



centrically arranged within said steam nozzle, means for supplying sand under pressure to said other nozzle, a duct for feeding steam to said steam nozzle through said ball joint and comprising another ball joint situated in the pivot axis of said fire door, and pipe connections from the source of steam to said last-named ball joint and from the latter to said first-named ball joint. Two claims.

1,868,413. SECTIONAL FLUID HEATER. H. MITCHELL GODSEY, OF SALT LAKE CITY, UTAH.

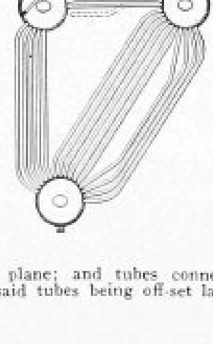
Claim.—A fluid heater comprising one-piece fluid-circulating sections arranged side by side to form a complete heater, each of said sections embodying an integral steam drum of substantially the same width as the



section and two vertical integral abutting baffles arranged to direct the flow of the products of combustion upward, downward and upward again across the sections of the heater. Eleven claims.

1,880,789. BOILER. CARL T. CARLSON, OF ERIE, PENNSYLVANIA, ASSIGNOR TO ERIE CITY IRON WORKS, OF ERIE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

Claim.—In a boiler, the combination of two drums having their axes in



approximately the same plane; and tubes connecting the drums in approximately said plane, said tubes being off-set laterally intermediate their ends. Three claims.

GET TOGETHER DEPARTMENT

POSITIONS OPEN POSITIONS WANTED

POSITION WANTED

EXPERIENCED layerout and foreman, now employed, desires permanent connection in Southwestern or Southern U. S. Age 31. Address Box 584, BOILER MAKER & PLATE FABRICATOR, 30 Church Street, New York, N. Y.

LAYEROUT or Foreman desires position. Experienced in all branches. Address Box 585, BOILER MAKER AND PLATE FABRICATOR, 30 Church Street, New York, N. Y.

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Boiler Maker and Plate Fabricator

The New Boiler Code

All of our readers at one time or another have occasion to refer to the American Society of Mechanical Engineers' Boiler Construction Code in carrying on their daily work. Many must depend upon it constantly for guidance in producing acceptable boilers and pressure vessels. To the designer, manufacturer, inspector and man in the shop executing the work, the code is invaluable.

The code is law in nearly half the states of the country and in many cities in addition. Through the efforts of the American Uniform Boiler Law Society in promulgating the code, its adoption by additional states and communities is being constantly advanced. That this work requires unceasing effort on the part of officers of that society is well recognized and appreciated throughout the industry.

All of the effort that has gone to developing the code and promulgating it would lack practical significance unless some means existed for the uniform enforcement of its provisions. To this end the National Board of Boiler and Pressure Vessel Inspectors was created and for nearly fifteen years has functioned with efficiency and an ever growing respect for its work on the part of the manufacturers and users of power boilers and pressure vessels. As is well known, the board is made up of chief inspectors of the various political subdivisions operating under the code and insurance inspectors.

It has come to our attention that some confusion exists concerning the code among the great body of inspectors whose duty it is to carry out the detailed application of the provisions and who must at times be required to make interpretations of specific sections. Further in many instances the technicalities involved are more or less beyond the grasp of the inspector in the field.

To those individuals who have experienced such difficulty, the new edition of the code recently published will be of very considerable assistance, since in it are included all the revisions of former years as well as interpretations which are given as supplementary information. It is understood that the interpretations of the code have been reduced from over 800 to some 170 in number—all in the interest of simplification.

At best it is a difficult task for each individual inspector to keep informed of ever-changing requirements—revisions and improvements in the code. It also is more than difficult for the code committee to bring about these changes and to interpret the many involved applications that the manufacturers would make.

Basically the requirements are comparatively simple and with these every inspector can become familiar by a careful study of the new code. The supplementary information gained from a comparatively small number of interpretations should be sufficient to equip him to meet all but a few of the most difficult problems he encounters. When an interpretation is required for which the code does not provide an answer, the matter should be referred to his chief and if not then forthcoming, the latter can always transmit the question to the code committee.

Since it is impossible in a fast-changing art such as that of boiler construction for the rules to remain fixed, everyone involved should be extremely grateful to the code committee for the extraordinarily complete and efficient work it has performed, as evidenced in the new edition of the A.S.M.E. Boiler Construction Code.

Examinations for Locomotive Inspectors

The announcement in this issue that examinations will shortly be held for Federal locomotive inspectors to fill vacancies in the Bureau of Locomotive Inspection will be good news to a large number of our readers who for years have studied patiently for a post of this kind.

Among those qualified to become inspectors none is better fitted than the experienced boiler maker, who from his practical knowledge of the requirements of safety is entirely competent to pass on the condition of locomotives. Other qualifications, however, are just as important. The future inspector must have an agreeable personality. He must be able in a reasonable and understanding way to maintain his relations with officials of the railroads, accomplishing those things necessary to safety but avoiding all show of bureaucratic treatment of any case. If his knowledge is broad enough so that he can properly interpret the law and enjoy the confidence and co-operation so essential to public relations of this kind, then he will be an acquisition for the Bureau of Locomotive Inspection.

Combined with these personal qualities, he must in addition be able to think clearly and to report accurately his findings. This matter of report writing which is so vitally important is not a simple thing to do. On an inspection job it reaches almost to that of a fine art, since there must be no doubt in the minds of anyone involved as to the exact meaning of the statements therein made.

Those of the boiler making fraternity who would become inspectors, undoubtedly are familiar with all the requirements and have studied accordingly to qualify themselves in all these matters. The positions to be filled by the chief inspector carry a high degree of authority and influence for good. The cause of safety can only be advanced when the Federal inspection staff is constituted of men embodying in high degree all the qualities of knowledge and personality set by the standards of the examination.

With sound preparation, the technical aspects of the examination should offer but little difficulty. As great care should be taken in preparing to meet the less tangible requirements on which inspectors will be selected.

Good luck to all our readers who enter the examinations. They can do so with the assurance that from the ranks of the boiler making fraternity many future inspectors will be selected.

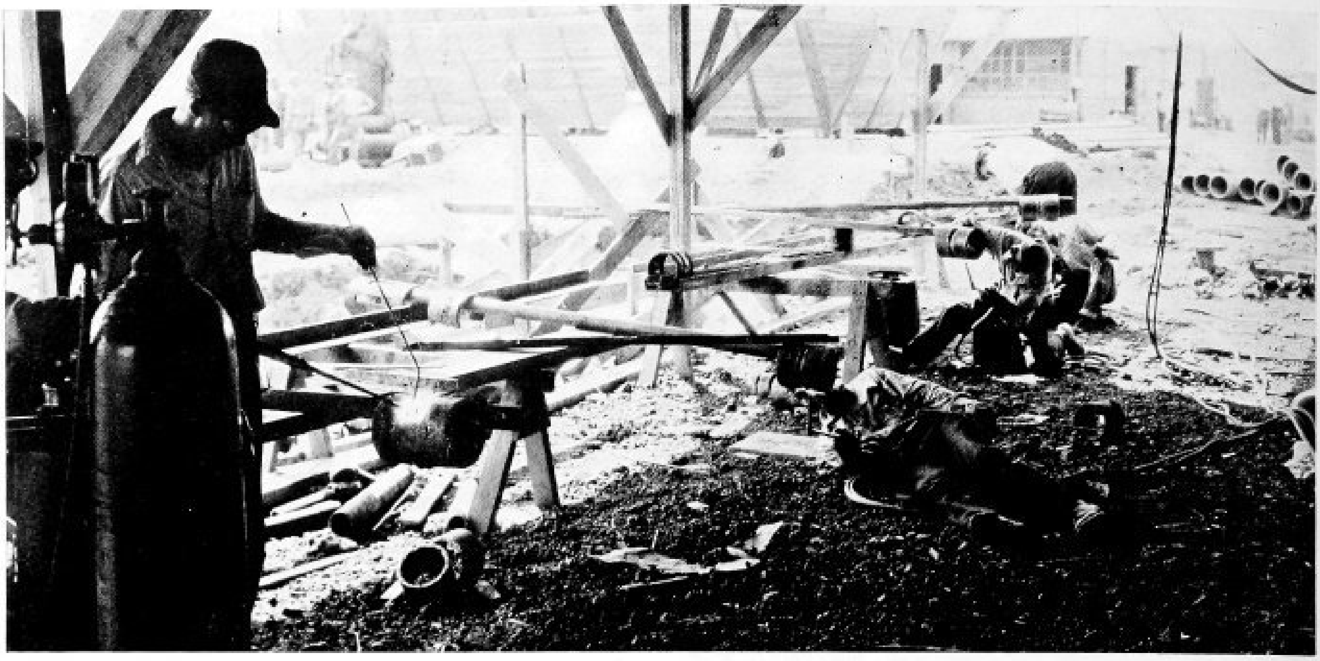

Fig. 1.—Student welders practising position welds at qualification school

Methods and procedure used in

QUALIFYING WELDERS

By G. O. Carter*

The matter of qualifying welding operators has an important bearing on the future of welding's place in industry no less than it has on the future of the welding operator himself. Correct qualification of those men who are to do important work is an essential part of procedure control. It means that the manufacturer will have definite assurance of obtaining a high quality product, and it means that the operators will in turn have trust placed in them as individuals. Since the ability to obtain uniformly consistent results in production is a factor in the continued use of welding by a manufacturer, this in turn very decidedly has a bearing on the future possibilities of a good livelihood on the part of welding operators. These are the reasons why the matter of qualification tests is gaining in importance.

Standard tests for proficiency in welding have been given careful study during recent years. While not all present-day plant managers, superintendents and foremen learned welding when getting their training, many of them today know what to look for in welding. They no longer try to pick a welding operator on the basis of the length of his service and the firms he has worked for previously. Length of service in any given trade is generally a check on a workman's proficiency, but it does not always indicate ability to do a particular job. These are facts which all managers and every prospective workman face. Today there are tests which soon demonstrate a man's proficiency as a machinist, a plumber, a brick mason, a carpenter or a welding operator.

This raises the question as to what constitutes satisfactory qualifying tests.

Because there is considerable variation in the welding technique for different metals, it is important that a welding operator be given a qualification test with the base metal and the type of welding rod which he will be called upon to use. In fact, all conditions in the qualification test should duplicate actual working conditions as closely as possible. The welded specimen for test should be of the same metal, of approximately the same thickness, prepared with the same bevel, and made with

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Fig. 2.—Field set for weld testing

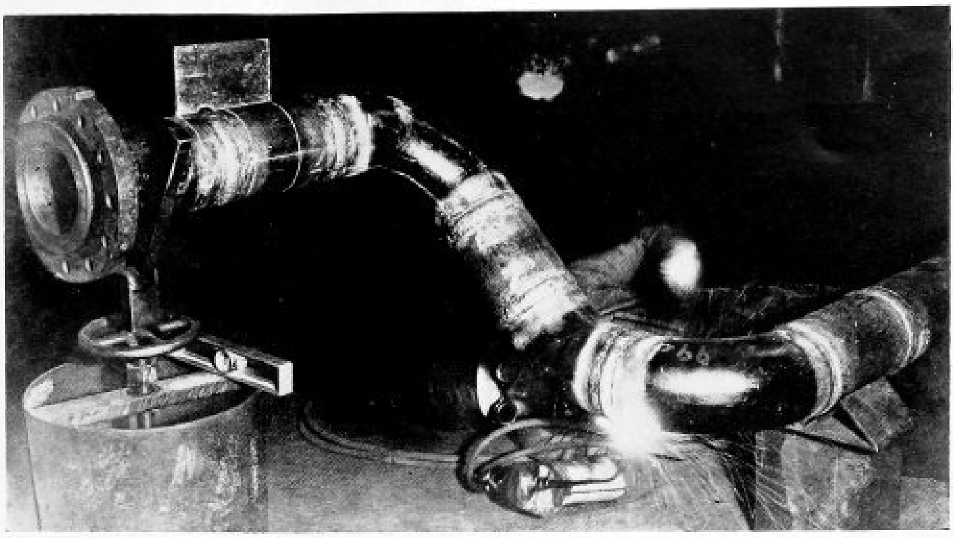


Fig. 3.—Speed and effectiveness in difficult position welding is acquired only by practice and experience on real welding applications

the same welding rod and flux, using the same welding head or tip and working in the same position as the operator will be called upon to use for the actual work.

The test pieces, when completed are cut into specimens or coupons and tested by one or several methods. The most important of these are the tensile, the fracture and the bend tests.

And in connection with those who fail to pass such a test the first time, an important word may be said. Some men may be operators of long standing; others may be beginners. Neither, however, need be discouraged by failure. Very often some easily detected and easily corrected error in welding technique may be the cause for failure to pass the tests. If this is so, the fault and the way to correct it should be pointed out to the operator. Then with enough practice to correct it, he should be permitted, in fact urged, to take the test again.

The Tensile Test

The tensile test is a test of ultimate strength of the metal. The test piece, Figs. 5 and 11, is pulled apart and the unit stress required to pull the specimen to pieces is determined. The preparation for this test is simple and requires little time. As mentioned before, the test pieces and conditions in so far as possible should duplicate the actual work.

The rate of welding should also be checked because many operators can make a good weld if they work slowly, but fail to make what might be considered to be a reasonable speed. Quality, on the other hand, is more important than speed, so the qualifying speed of welding should be reasonable and should approximate the anticipated speed in production welding.

A good illustration of a qualification test piece for tensile testing is that for plate material. Each of the two pieces to be welded for the test preferably should be long enough to allow for 5 tensile coupons, 2 free bend specimens and 1-inch strips at each end for rejects. They should be about 9 inches wide. The bevel or edge preparation should be along the longer side. The finished test piece, properly welded, should be cut to give the several test pieces as shown in Fig. 6. A 1-inch strip is discarded from each end of the plate and the coupons for tensile and bend tests cut from the center and machined. In other words, the regular standard tensile test piece of the American Society for Testing Materials is obtained. These test pieces should then be pulled to destruction in the tensile testing machine. Readings should be obtained as to the elastic limit, ultimate strength, elongation both in 8 inches and 2 inches, and for reduction of area. These determinations, of course, are for the whole test piece and not just the welds alone. If the fracture occurs in the weld, the nature of the fracture should be determined and stated.

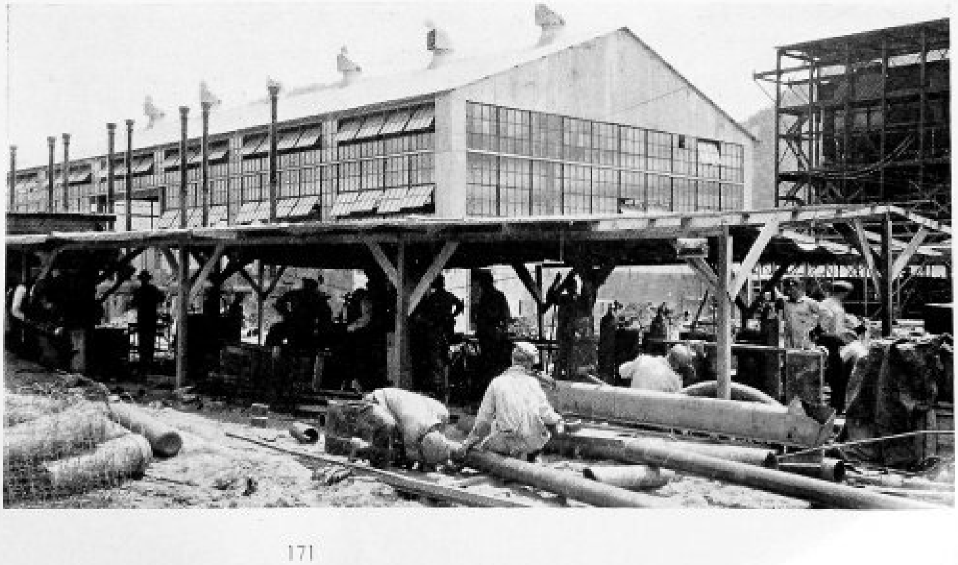


Fig. 4.—Welding qualification class on location. This undertaking can be carried on either indoors or out depending on weather and space conditions in that area

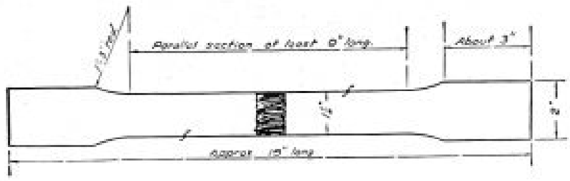


Fig. 5

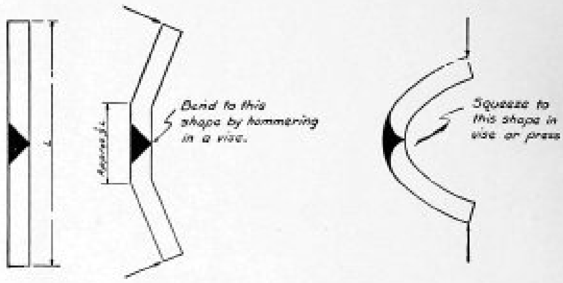


Fig. 8

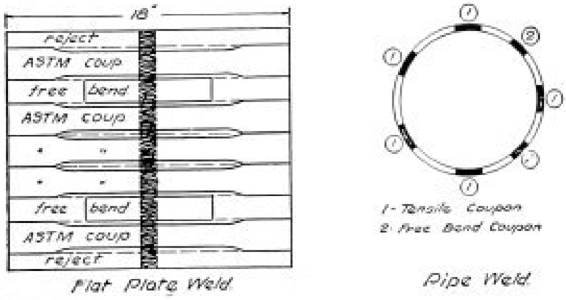


Fig. 6

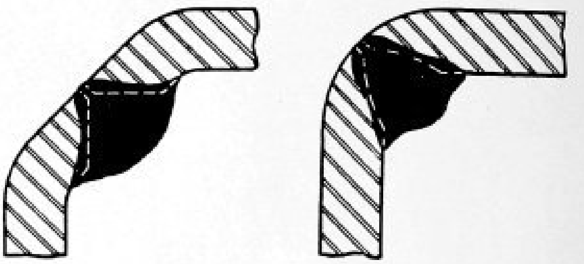


Fig. 9

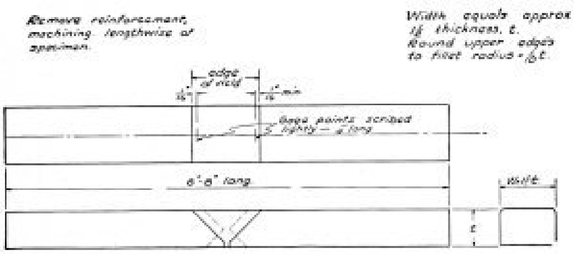


Fig. 7

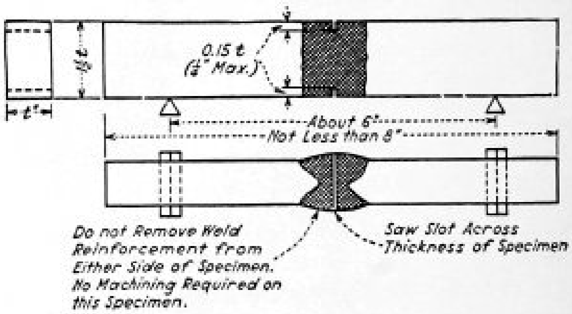


Fig. 10

Where standard tensile testing machines are readily accessible, either in the plant or at a testing laboratory, this constitutes an ideal test for qualification purposes. Good results can also be obtained from pulling other than standard test pieces. With the modern portable tensile testing machines that are now available, Fig. 2, tensile tests for qualification purposes can easily be carried out on the job or field location. Test pieces for use in these machines are somewhat smaller, but the same results are easily obtained.

The Bend Test

A simple test, known as the free bend test, gives an accurate quantitive measure of ductility. In this the amount of stretch in the outside fibres of the weld metal is measured. The elongation is measured between two gage points or lightly scribed marks which were placed in position *before* bending near the edges of the weld, preferably ½ inch or 1 inch apart. The coupon is prepared for bending either by machining or by careful flame cutting and grinding. It is then kinked 15 to 20 degrees at each end adjacent to the weld, as shown in Figs. 8 and 12. Thus, when it is bent further, the stresses are concentrated in the weld.

The test piece is then placed in a vise or between the heads of a suitable testing machine or press and an axial load applied. As the bending progresses the weld surface is watched carefully for the first sign of failure, and then the loading is stopped. The distance between the gage points or marks can be measured with a flexible rule and the percentage of elongation determined by a simple mathematical calculation.

The Fracture and Nick-Break Tests

One of the weaknesses of novices with the welding blowpipe is that weld metal is deposited without the base metal being molten. This results in an adhesion instead of a weld. Frequently the upper part of the base metal is melted and a good weld is made in a thin layer, but without weld metal reaching to the lower edge of the plate. This condition is called "lack of penetration, or making a skin weld." A poor weld may be made involving lack of fusion at the bottom with only a "skin weld" at the top.

The breaking of a few test pieces by one of the two fracture methods will better demonstrate the characteristics of welds than all the writing that can be done. Observation of the fracture will quickly indicate the quality of the weld metal and disclose any errors in technique. Lack of complete fusion, cold shuts, oxide inclusions, porosity, and similar defects of the poorly made weld are easily revealed by such an examination after the test is performed.

The backward bend test, Fig. 9, which is usually

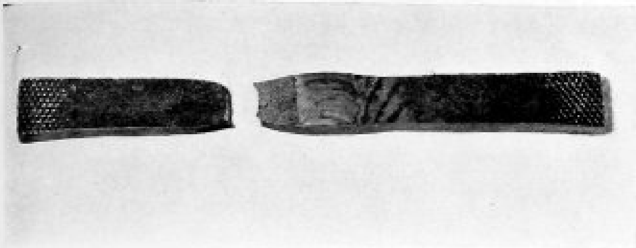


Fig. 11.—Test piece coupon

made on single-vee welds in pipe and light plate, is a combination of bending and fracturing. The zone of weakness in a weld that has any ordinary defects is the bottom third of the vee. Hence, the bend is so made as to place a severe stress upon this portion rather than upon the adjacent base metal. A coupon of low merit fractures readily.

The only equipment needed is a sturdy machinist's vise and a medium-sized maul. Representative coupons cut by the flame if desired from each weld usually are from 1¼ to 1½ inches wide and about 6 inches long. These dimensions can be varied to suit conditions; exact size is immaterial. Then the coupon is clamped upright in the vise, with the bottom of the vee to the front, and the center line of the weld about ¼ inch above the top of the jaws.

By hammering, the coupon is bent backward—away from the inspector—until it breaks. Fracture usually occurs about in the center line of the weld after the coupon has been bent through an angle of 90 degrees.

The nick-break test, Fig. 10, also designed to permit examination of the weld metal, is about the same type of test, except for the preparation of the coupon. By slotting the side center across the thickness of the weld and placing the specimen on supports about 6 inches apart, a sudden blow will cause a sharp, sudden fracture through the nicked portion.

These tests are simple and enable the man to see his work and, if faulty, why. Defects are generally due to faulty technique, and by pointing out the cause, correction in technique is easy and a first-rate operator is developed. It is obvious that qualification tests can be applied to any metal, with such modifications as may be made necessary by the specific properties of the metal under consideration. Thus, the bend test would be of no value for a fusion weld in cast iron, but the fracture test would give valuable data concerning the operator's ability.

Another point to keep in mind is that just because a man is proficient on sheet material it does not necessarily follow that he can satisfactorily weld ½-inch steel plate, or even ¼-inch material. All of this testing may appear to be quite intricate and involved, but it really is not hard to carry out in practice. And it certainly saves a great deal of trouble at the expense of a little organization.

Suppose an important piece of equipment is planned and the engineer or superintendent of the job directs that a tensile qualification test be made. Two pieces of metal of approximately the same thickness as called for in the design can be welded in a few minutes and can be pulled in a testing machine or given the free bend test in an hour with an interval of say a day if machining is necessary.

The commonly accepted requirements, 45,000 to 52,-000 pounds per square inch tensile strength, for steel are reasonable when applied to the average run of welding rods, but are not an adequate measure of a high strength rod such as high test steel. The properties of

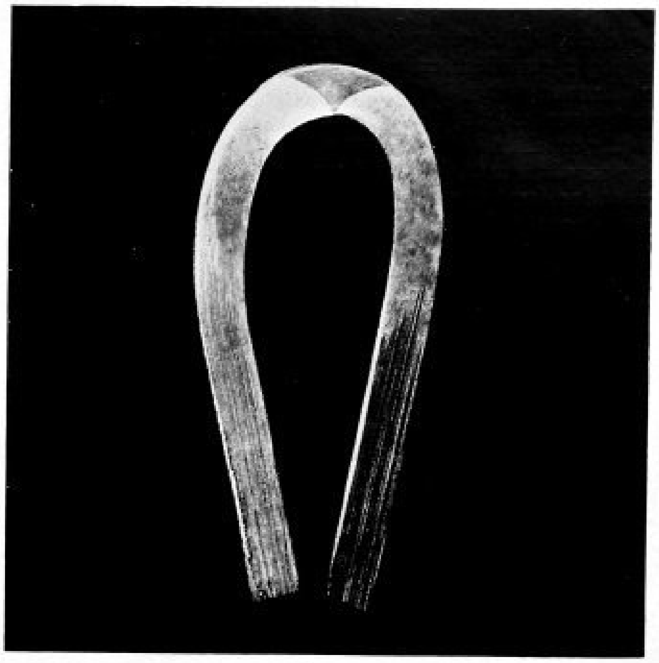


Fig. 12.—Free bend test coupon

this rod are such that the strength of the weld metal itself is close to, if not greater than, the strength of the material being welded. In mild steel, the strength of the weld metal is comparable to the ultimate strength of the base metal, 50,000 to 60,000 pounds per square inch, while with high strength material that is relatively high in carbon (carbon 0.34 to 0.45) the same welding rod will develop a strength as high as 90,000 to 100,000 pounds per square inch or equivalent to the ultimate strength of the material being welded.

What engineer would not prefer to have this kind of a record of workmanship to go by instead of trusting to luck that he had a good operator at work on his product?

Where facilities are available it may be desirable on specially important work, to make macroscopic and microscopic investigations. Polishing and etching a test piece brings out flaws and segregations, while the microscope shows the character of the grain structure. This refinement of testing has proven to be advantageous to those concerns that do a great deal of welding that is classified under the various codes and regulations.

During the progress of an extensive welding job, it is often worth while to have each operator make a qualification test at intervals. At the same time his apparatus should be looked over by an experienced repairman or by the foreman. It will be found to pay to do this.

Welding operators may possibly wonder what good all of this is as far as they are concerned. There is this to be said. For the company doing the work, the knowledge that the operator's work is being properly done and his joints are sound means a satisfaction with the process. No company is going to hire a man to work at a process in which they do not have entire faith. Qualification tests prove that the man can do first grade work, and prove to the manufacturer of the product that his product will be good. Therefore, work of this nature will continue and will increase in volume. This means a job for the operator.

Or the operator can look at it from another point of view. He can consider that the manufacturer is already certain of the value of welding, probably because he has had good work turned out before and knows what can be done. The prospective employe in welding who is taking a qualification test will also have the satisfaction of knowing that if his tests are good he will be hired and given a job. In most cases he will also know that if his qualification tests are not sufficiently good to pass the requirements, he will be given an opportunity to see what his faults are and to correct them. In fact a great many companies employing many welding operators regularly maintain instruction courses in welding for those of their men who wish to qualify for better grades of work.

Considered from the long range standpoint, therefore, qualification tests have a very definite place in the future scheme of industrial fabrication work. Detailed information on these tests can be obtained through the various code bodies regulating the production of equipment and products that are covered by the codes, from the International Acetylene Association* an organization which can supply all available information on the various phases of the process, and from any of the manufacturers who make welding and cutting apparatus, supplies or manufacture the gases.†

A splendid illustration of the way in which the training and qualification of welders was applied in actual practice occurred recently in connection with the construction of a large plant in one of the process industries. Specifications called for the installation of a large amount of complicated oxwelded piping both for high pressure and low pressure service. As is usual with process piping, a large percentage of the welds were of the nonrotating or position type, some horizontal, some vertical and others at various intermediate angles.

It was estimated that about fifty welders would be required to complete the installation on schedule. As the contractor did not have that number of trained pipe welders available, arrangements were made through various offices of the contractor and through other organizations to obtain the necessary men.

Realizing the importance of having all the welders properly qualified for this work, the contractor requested the assistance of the welding engineering department of his oxygen supplier. An engineer was assigned to supervise the installation of a system for qualifying the welders and to instruct one of the contractor's men in the details of the testing procedure so that the qualification of welders could become a routine practice in the contractors' organization.

Due to the large percentage of position welds required in the installation work, it was decided that the qualification test should consist of one horizontal fixed position weld and one vertical fixed position weld in 6-inch extra heavy pipe, using high test welding rod. Test welds were made on two short sections (at least 8 inches long) of the pipe beveled in accordance with the specifications for the standard open single vee butt weld. The welds were tested according to the standard specifications.

The majority of those applicants who failed to pass the qualification test seemed to offer possibilities for intensive training, and accordingly it was suggested that a school be established. This would give those who were below standard an opportunity to receive instruction which would correct their faulty technique and to practice until they felt qualified to take the test again.

Before placing the school in operation, the welding engineer called this group of welders together and explained the proposed plan. He talked to them concerning the probable defects in their welds, the corrective measures which should be employed to eliminate them, the correct practices which should be every welder's knowledge, the methods of rating of the test welds, and emphasized that the employers were not expecting the impossible from them.

It was pointed out that the demand on the welder's skill was merely that he be at least an average welder, securing sound deposit of metal, fusion to the side walls, and thorough penetration; that the demand was not for exceptional welders, since the use of high test welding rod made the average weld with this rod equivalent in strength and soundness to an exceptional weld with ordinary welding rod.

The men received this plan with great enthusiasm, and by the end of the first day of school several of them passed the qualification tests for high pressure work. It also became apparent that there was a distinct increase in morale among the successfully qualified welders. To most of the men, the importance of their work increased in their own minds due to the tests to which they had submitted and passed. Furthermore, the news of the school and the tests spread far and wide indicating the interest with which the results were being watched.

The coaching in the school showed good results. The next day five men who had been on the awkward squad made excellent showings on the repeated qualification tests, and the balance of the men indicated aptitude in the rectification of their faulty technique. Their main difficulty lay in their inability to handle bell-hole welds, having laps in the bottom and top sections, and poor penetration on the under half of the weld. These difficulties were rapidly ironed out by practice work and intelligent supervision.

Group after group of men applied for work. They were given the test and either qualified, or were put in the training school. After about half the required men had been properly qualified, it was noted that about 800 welds had been completed and tested in the installation, and, in all, only two slight leaks had developed.

Safety Valve Installation

Joseph B. Weaver, director of the Bureau of Marine Inspection and Navigation, has issued a circular letter to boiler manufacturers, shipbuilders, supervising, traveling and assistant inspectors concerning the installation of safety valves, as follows:

The Bureau of Marine Inspection and Navigation has been asked to rule as to whether it is permissible under the terms of Rule II, Section 14, to connect safety valves to fittings attached to the boiler which fittings are equipped with outlets for main or auxiliary steam lines.

It is the opinion of the bureau, and also of prominent safety valve manufacturers, that it is extremely bad practice to connect safety valves to fittings used for steam outlets on boilers. It is a recognized fact that when steam has been taken through the same fitting it causes a chattering of the safety valve disk on the seat, which seriously affects satisfactory performance and causes excessive wear of the working parts of the safety valve.

Instructions are therefore being issued, when installing safety valves to make sure they are not connected to any fitting which is equipped with outlets for any other purpose than the escape of steam through the safety valve.

* *Tests for the Selection of Operators of Welding Equipment* (tentative) Section VI, Oxy-Acetylene Committee, International Acetylene Association, 30 East 42nd Street, New York, N. Y.

† *The Testing and Qualification of Welding Operators*, published by The Linde Air Products Company, 30 East 42nd Street, New York, N. Y.

American engineers have important part in

Developing the Super Pressure Boiler

By I. E. Moultrop*

There are many reasons why the modern boiler is a safer piece of apparatus than those in use two or three decades ago. I can say that from personal experience. In my early career I was an apprentice in a machine shop and boiler shop. We built elevators, steam engines, etc., and boilers. I spent some little time in the boiler shop and I know how boiler construction was carried on in those days. Why more boilers built in some shops did not blow up, I do not know.

The careful periodic inspection of boilers, with which the National Board is so familiar, enables the operating engineer to change his operating practice before any dangerous condition has developed, and to make minor repairs at low expense, instead of major repairs or replacements at great expense.

The development of satisfactory feed-water treatment processes and control technique has made it possible to maintain the inside surfaces free from scale and to reduce corrosion and embrittlement failures to a very low figure. Protective coatings for the inside surfaces have also helped in the fight against corrosion. Better design, based on more complete knowledge of the stresses involved and the properties of the materials of construction, has been an important factor. Whereas at one time boilers were manufactured in steel plate shops, today they are usually built in a machine shop with precision tools and machines.

In speaking of high pressure boilers, the term "high pressure" is entirely relative. Fig. 1 shows the pressures and temperatures used, during the past forty-five years in the boiler plants of the company with which I have been associated. Thirty years ago 200 pounds per square inch was high pressure (the first 200-pound pressure boiler we put in created as much interest as the 1200-pound pressure boiler installed a short time ago), fifteen years ago 300 pounds was high pressure and ten years ago the first commercial 1200-pound pressure boiler was installed in our Edgar Station as shown in Fig. 2.

Since then, boilers have been operated in commercial service at 3200 pounds per square inch and experimental boilers at pressures considerably higher. For the purposes of this paper, we will consider anything above 1000 pounds as high pressure. That does not apply to England, where they have standardized on pressures around 650 pounds which is called high pressure over there. The boilers described in this paper are coal-fired and equipped with underfeed stokers. In the latest designs of high-pressure boilers the boiler itself is a very simple piece of apparatus, but unfortunately, after superheaters, reheaters, economizers, air heaters and water-cooled furnace walls have been added, the complete steam generating unit is not quite so simple.

The first commercial boiler for a pressure of over 1000 pounds was installed in our Edgar Station in 1925. Fig. 3 at the left shows a cross section of this boiler, as it was originally installed. The boiler contained 15,732 square feet of heating surface and was provided with a superheater, reheater and economizer. The drum was forged from a single steel billet. I think that was the first instance anywhere where a large drum was forged from a billet and it created considerable interest and some excitement at the time it was furnished.

One of the first problems in connection with this installation was that of securing a fusible plug for the high pressures and temperatures involved. The Boiler Code requires a fusible plug. The Massachusetts Board of Boiler Rules requires a fusible plug. In my opinion the fusible plug is a nuisance. After some discussion with the authorities, it was agreed that the fusible plug requirement was not a reasonable one for such a boiler, and the boiler was installed without one. They did not come to that conclusion until they exhausted their resources as to how to make a fusible plug. Therefore, they let us put in the boiler without it. I would not use a fusible plug for any boiler above 300 pounds pressure, and I think that is something we ought to get rid of as soon as we can.

* Chief engineer, Edison Electric Illuminating Company of Boston, Mass. The paper of which this is an abstract was delivered at the tenth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors, New York.

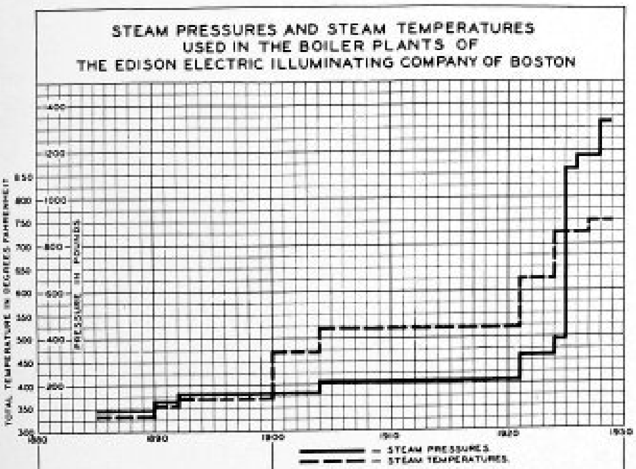


Fig. 1

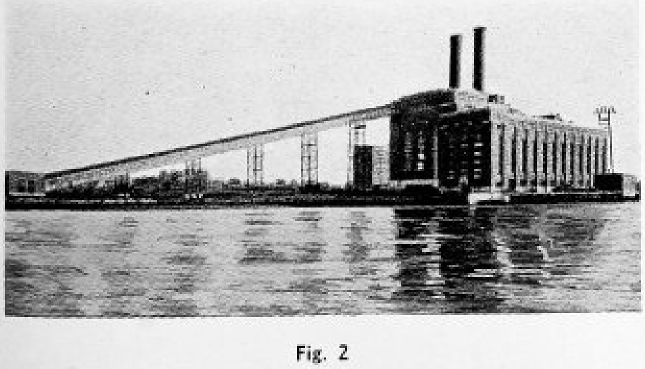


Fig. 2

No one had ever built a steam safety valve for any such pressure, and it was thought that the operation of such a valve would destroy the seats. The best possible valves were built, however, and one-inch pilot valves set for a somewhat lower pressure were installed to give warning when the drum pressure approached the setting of the main valves and possibly save them from blowing. Experience showed, however, that the 1200-pound pressure safety valves operated just as satisfactorily and with apparently no more wear than valves for moderate pressures, and the small warning valves were removed. There is one thing we did find out—not entirely in connection with the use of safety valves, but with the entire installation—namely, that a leak under this pressure cuts fast. You must not let a leak exist. If you do, you are going to ruin the surface exposed to that leak because it will cut at a surprising rate.

No one had ever built a blow-off valve for such a high pressure. A valve was cut from solid steel stock by the boiler manufacturer and has proved very satisfactory. Today several manufacturers build satisfactory valves for this pressure in this manner.

We do not consider the ordinary round gage glass a suitable design for the high pressure; so the flat type of gage glass, which is now used quite extensively, was developed for the purpose. The use of a flat glass was not new but the water column, try cocks, etc., had to be specially designed.

All boiler tubes in the first 1200-pound boiler were 2 inches in size and were spaced too closely together. The molten ash in the gases plugged up the passages and required frequent de-slagging. Fig. 4 illustrates this condition. This was remedied several years later by the installation of a slag screen of 3¼-inch tubes below the lower bank of 2-inch tubes.

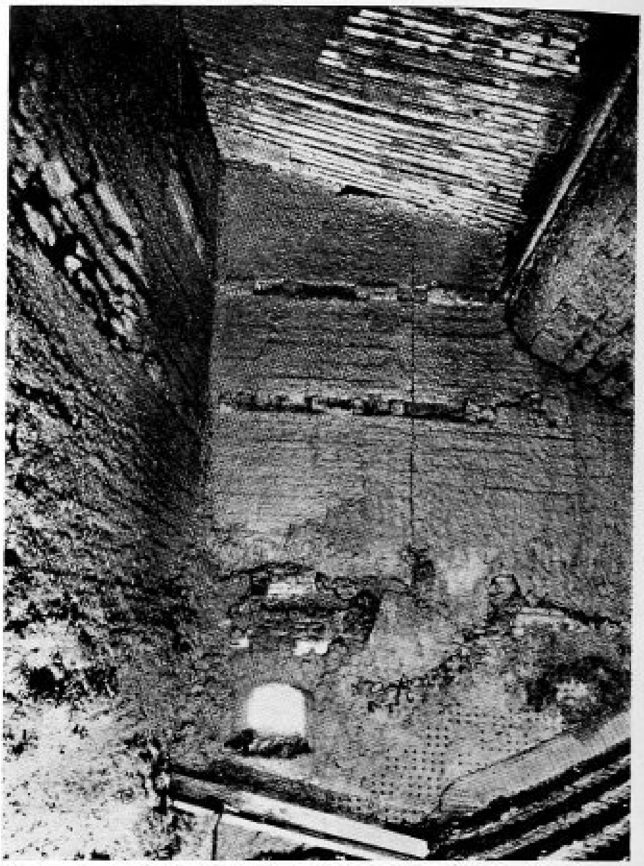
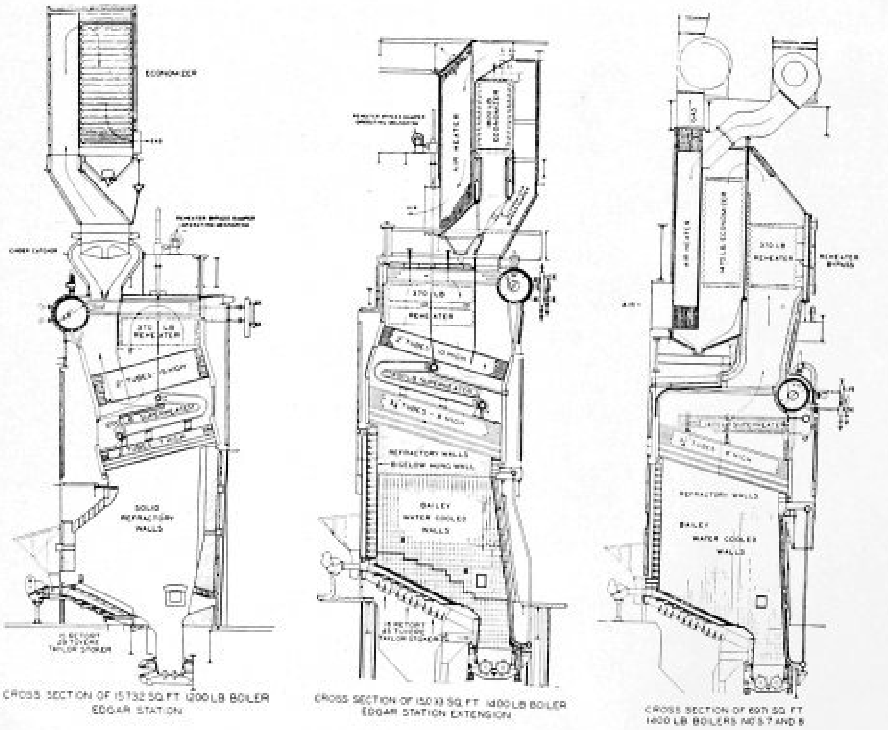


Fig. 4

The 1200-pound steel tube economizer gave considerable trouble due to leaks at the rolled joints. However, even more serious troubles of a similar nature were experienced with the 350-pound economizers of a similar design installed at the same time. This quite conclusively pinned the trouble on the design of the apparatus. Both the 1200-pound and the 350-pound economizers were rebuilt and our leakage trouble practically disappeared. This was due to the fact that provision was not made for expansion.



CROSS SECTION OF 15732 SQ. FT. 1200 LB BOILER EDGAR STATION

CROSS SECTION OF 15033 SQ. FT. 1400 LB BOILER EDGAR STATION EXTENSION

CROSS SECTION OF 6971 SQ. FT. 1400 LB BOILERS NOS 7 AND 8

Fig. 3

When the first 1200-pound boiler was installed, no automatic feed water regulator was provided because of our fear that such apparatus would require considerable development work and might get us into trouble. After operating experience had showed how the high-pressure equipment acted, we installed feed-water regulators and they have performed just about as well as they do on normal pressure installations. This brings up an important point: You do not have the same proportion of water storage in the drum of a high pressure boiler that you have in a normal pressure boiler. The cost of the drum is very considerable. Naturally you want to keep the size of the drum down as small as you can. The whole boiler is pretty expensive and you want to get as much work out of it as you can; consequently, you run that boiler at a higher rate than the normal pressure boiler.

In the drum of a normal pressure boiler you may have a reasonable reserve of water when the feed supply stops; in the installation under discussion the reserve was less than four minutes, which is running pretty close.

Comparison of Size and Capacity—High-Pressure Cross-Drum Boilers—Edgar Station

Boilers, number	3	5 & 6	7 & 8
Pressure for which boilers were designed — lbs.	1,200	1,400	1,400
Boiler heating surface — sq. ft.	15,732	15,093	6,971
Superheater surface — sq. ft.	2,923	3,483	5,096
Reheater surface — sq. ft.	5,938	8,879	6,936
Economizer surface — sq. ft.	11,091	5,596	9,634
Air heater surface — sq. ft.	0	33,032	29,665
Water cooled furnace wall surface — sq. ft.	0	1,235	1,206
Total surface — sq. ft.	35,684	67,318	59,508
Temperature of steam leaving superheater	700° F.	733° F.	750° F.
Temperature of steam leaving reheater	700° F.	750° F.	750° F.
Temperature of feed water entering economizer	250° F.	420° F.	420° F.
Capacity in pounds per hour	143,000	250,000	300,000

The later designs incorporate water-cooled furnace walls of the block covered type. Soon after the first boilers with water walls went into service, we experienced a failure of a water wall tube. Investigation showed that the circulation was faulty. This was remedied by additional circulating tubes, and no further failures have occurred. Fig. 5 is a typical water-wall tube failure.

We have also experienced superheater tube failures and investigation disclosed that these also were due to improper circulation or distribution between parallel tubes. As soon as this was corrected, superheater tube failures ceased. Troubles with distribution resulted in the development of the so-called "trombone" superheater shown in the latest of the three designs in Fig. 2. With this design the major part of the pressure loss takes place in the superheater tubes and automatically gives good distribution between the tubes instead of having the major pressure loss in the superheater header, as in the older design, which invites poor distribution.

As a matter of fact, it was rather fortunate that these few water-wall and superheater tubes failed early in the development of the high-pressure boilers. These failures taught us a lot and gave us a much greater sense of security. When a normal pressure tube fails, it usually spreads the tube at the point of failure to a point where the full area of the tube, from both sides of the failure, discharges through the rupture. Due to the greater wall thickness and consequent stiffness of a high-pressure tube, the opening caused by a failure is usually smaller in area than the sum of the areas of the tube on both sides of the rupture. Consequently, in spite of the higher pressure, the high-pressure tube does not create as much disturbance as you might imagine. In none of the cases of failure which we have experienced has the accident caused the discharge of steam outside of the boiler casing. The failures have always vented themselves to the chimney. Fig. 6 shows a superheater tube failure where the rupture is unusually large and Fig. 7 shows what usually happens.

Because of the high cost of the boiler drums for high-pressure boilers, the water storage capacity has been rather small. Furthermore, the high cost of the boiler proper has resulted in operation at higher and higher outputs per foot of furnace width, and this again has reduced the effective water storage in the boiler. As an example of this, the first 1200-pound pressure boiler was designed for a maximum capacity of about 5000 pounds of steam per hour per foot of width. The latest

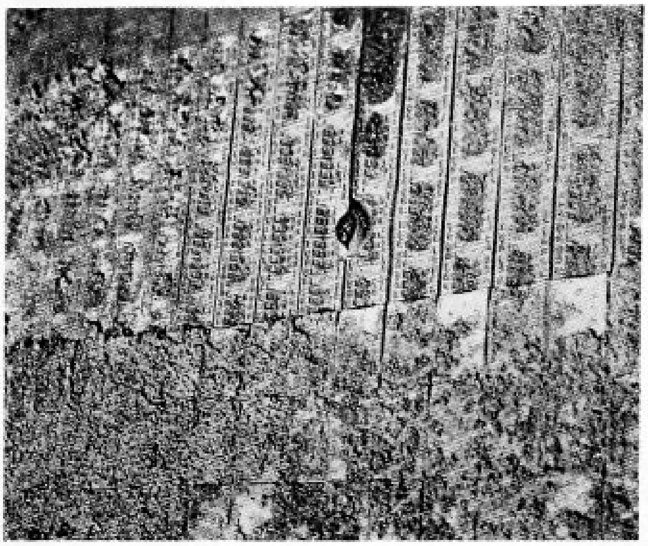


Fig. 5

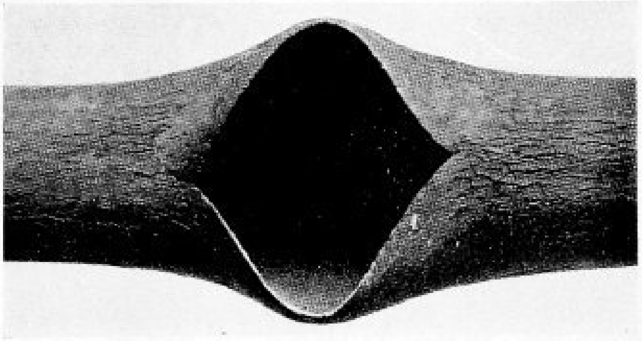


Fig. 6

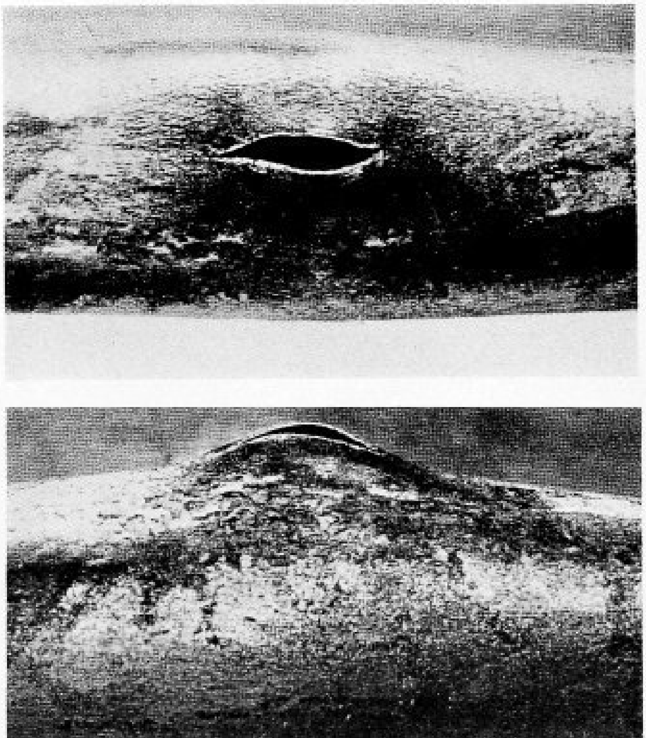


Fig. 7

design shown in Fig. 2, and installed only four years later, has a maximum capacity of over 10,000 pounds per hour per foot of width. Low-pressure boilers are in service today which develop 20,000 pounds and the boiler manufacturers believe that a capacity of 40,000 pounds per hour per foot of width is possible.

While we had a number of superheater tube failures and water wall failures, the most interesting thing about the whole situation is that a tube failure under this pressure is not serious. There are no disastrous effects from it. You will notice how the tubes opened up. You get a hot spot, it bulges out, and then it splits. It does not tear wide open for a considerable distance. You get no serious disturbance from it. No steam or fire has even been blown outside the walls of any of our boilers. There is considerable commotion inside, and that is all. In one case we had a superheater tube split and it was not convenient to take the boiler off the line immediately. We hung on to the boiler for some time before we shut down. You probably can maintain service until it is convenient to take it out. All of these occurrences should not be disturbing. They are caused simply by a lack of knowledge or understanding of the behavior of steam at elevated pressures and a bit of lack of understanding of the importance of circulation. As soon as the matter of circulation was properly attended to, we had no further failures. While I do not want to be in the vicinity of an ordinary pressure boiler when a tube lets go, I have been alongside one of these tubes when it let go, and it was not very exciting—as a matter of fact, it was rather interesting.

The use of water-cooled furnace walls which are more circulation-sensitive to variation of water level in the boiler drum has furthermore reduced the effective water storage capacity of the drum.

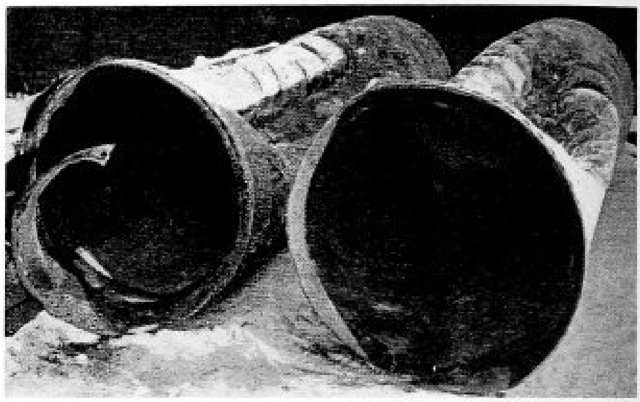
When the first high-pressure boiler was put in service, as you can well imagine, the operators were very careful in their starting and operating procedure. As they became more familiar with the operating characteristics of the high-pressure boiler, they found that this extreme care was not warranted. They now operate the high-pressure boiler with the same confidence and nonchalance and in the same manner as they do a normal or low-pressure boiler, with one exception—they take about 50 percent more time in putting a cold high-pressure boiler on the line in order to give the thicker boiler parts more time to reach their operating temperature. This is done as a precaution; we really do not know that the extra time is necessary.

We have often discussed the matter to see if there are any other designs or operating limitations for high pressure boilers. Every limitation suggested can be shown to be just as important in the case of normal pressure boilers. From the standpoint of safety, we needed the right quality of water for boiler feed and in the boiler itself, and we need a dependable and reliable feed-water supply and feed-water regulator. The main limitations of high-pressure boilers come in their design and construction, and I am not so sure but that in the final analysis all of such limitations apply to normal pressure boilers as well. A major boiler failure can result in the loss of life and the destruction of property whether the boiler is operated at 100 pounds or at 1400 pounds. On the other hand, greater care in detail is undoubtedly necessary in the design and construction of high-pressure equipment. Rolled joints must be rolled clean metal to clean metal; screwed joints are always the cause of trouble unless seal welded. I think the day is coming soon when there will be no bolted or screwed joints in the better grade of power plants. These parts are stiffer and temperatures higher. Expansion stresses must be taken care of properly.

In conclusion, we believe that no one need hesitate to install high-pressure boilers of the conventional designs. They can be operated with the same type of personnel as required for the operation of normal pressure boilers and, with intelligent operation, will give no more operating troubles than boilers designed for more moderate pressures.

Scotch-Marine Furnaces Collapse

Two corrugated furnaces in a 103-inch diameter Scotch marine type boiler collapsed at a Pennsylvania textile mill early this year. The fires had been banked, but the fireman had been directed to bring the boiler up



Collapsed Scotch marine boiler furnaces, the result of overheating

to pressure—125 pounds. The fireman said that because the gage glass was full of water, he had opened the blow-off valve, letting the water down to about half a gage, but had not disturbed the banked fire. About a half hour later he observed smoke issuing from the front of the boiler and on opening the fire doors saw that the furnaces had collapsed and were pressing against the grates. Whatever the train of events, it was evident that the furnaces, each 36 inches in diameter and 13 feet 3 inches in length, had collapsed because of a condition of low water and overheating, brought about, probably, because of failure to close the blow-off valve tightly. The replacement of both furnaces was necessary.—*The Locomotive.*

Classification of Iron and Steel Scrap Approved by Industry

The current revision of Simplified Practice Recommendation R58-28, Classification of Iron and Steel Scrap, has been accorded the required degree of acceptance by the industry, and is to become effective June 15, 1936, according to an announcement by the Division of Simplified Practice, National Bureau of Standards. The revised recommendation will be identified as Simplified Practice Recommendation R58-36, and will remain in effect until again revised by the industry.

The original recommendation, which became effective July 1, 1926, specified classes of scrap for blast, basic open-hearth, acid open-hearth, and electric furnaces for gray iron foundry practice, Bessemer converters, and for miscellaneous scrap. A contract form for purchase of scrap is also included. The revision covers certain additions and eliminations to meet current needs.

Research Committee on Boiler Feed Water presents

Studies on Caustic Embrittlement

At the recent annual meeting of the American Boiler Manufacturers' Association, held at Skytop, Pa., W. F. Keenan, Jr., presented a summary of the activities of subcommittee No. 6 of the Joint Research Committee on Boiler Feed-Water Studies. The review particularly concerns itself with the subject of caustic embrittlement. Details of the organization of the committee appear in a brief report on page 156 of the June issue. The review is as follows:

Progress Made in Combating Embrittlement

Caustic embrittlement is the term generally applied to that type of boiler failure considered to occur as the result of two imposed conditions: First, the metal being stressed beyond its yield point; second, the metal being in contact with a water solution of chemical salts, such that certain established ratios between the concentration of sodium sulphate and the total or methyl orange alkalinity expressed in terms of sodium carbonate are not satisfied. The failure of boiler metal under these conditions is typified by cracks that are considered predominantly intercrystalline as opposed to intra or transcrystalline cracks.

This type of boiler failure has been known for many years, and a great deal of time and money has been spent in attempting to explain its development and intelligently to combat its occurrence. The boiler manufacturers were the first group to study intensively the phenomenon. Through their efforts it became apparent that this type of failure occurred regardless of the make of the boiler, the type of steel, or method of fabrication, under boiler water conditions such that a ratio of the concentration of sodium sulphate to the concentration of total alkalinity, expressed in terms of sodium carbonate, was less than one.

Professors Parr and Straub of the University of Illinois began in 1923 the systematic collection of operating data from a large number of plants using boilers for steam generation for the purpose of more accurately substantiating the information made available by boiler manufacturers. The work of these two gentlemen was augmented by laboratory studies in which various kinds of boiler steel were subjected to stresses beyond the yield point in the presence of all types of water. The results of these studies have in general confirmed the operating data gathered by the boiler manufacturers, and have so served to extend the knowledge of the cause and prevention of this type of failure as to indicate that ratios of sodium sulphate to total alkalinity should, under conditions of modern boiler operation, with reference to temperature and pressure, be as great as two in some cases and in others as great as three.

Very briefly, the theory for the cause and prevention of caustic embrittlement, which has resulted from these investigations, is that embrittlement results from the attack of caustic soda in concentrations in excess of one hundred grams per liter, on the crystal boundaries of metals stressed beyond the yield point; and that this attack may be prevented in the presence of a sufficiently high concentration of sodium sulphate. It is held that sodium sulphate prevents the occurrence or development of caustic embrittlement by coming out of the solution and depositing on the metal surface before the concentration of sodium hydroxide reaches that point necessary to enable it to attack the iron. Industry in general has accepted this theory for the cause and prevention of the phenomenon. There are, however, some investigators and some operators whose experiences are such as to cause them to doubt the correctness of the theory.

Disregarding for the moment the fact that some operators and some investigators do not subscribe to this theory, its successful application to the modern power plant depends upon the accurate knowledge of the solubility of sodium sulphate in boiler water containing a great variety of dissolved salts under a variety of temperature and pressure operating conditions. In an effort to obtain more exact data on the solubility of sodium sulphate in boiler water, the Joint Research Committee on Boiler Feed-Water Studies, through its appropriate subcommittee, and acting under the supervision of the American Society of Mechanical Engineers, is directing an investigation at the United States Bureau of Mines Non-Metallic Station at New Brunswick, N. J.

This study was initiated when its importance was pointed out to a group of large boiler operators, who in turn agreed financially to sponsor the investigation, provided it was carried out under the direction of the American Society of Mechanical Engineers. This society agreed to direct this work through the Joint Research Committee on Boiler Feed-Water Studies, of which the A.S.M.E. is one of the six sponsor societies. The Joint Research Committee in turn delegated the direction of this investigation to its appropriate subcommittee under the Chairmanship of J. H. Walker of The Detroit Edison Company. Funds for the financial support of the investigation were obtained as contributions from private concerns, principally steam electric power generating companies, through the efforts of the committee members, especially those of its chairman and of the Hagen Corporation.

The original objective has been attained and the work completed to the present time has yielded the following results:

1. Accurate data on the solubility of sodium sulphate in boiler water salines have been obtained. These data are available in such forms as to make their application to the problem of the treatment of boiler water for the prevention of caustic embrittlement easy and accurate.

2. Additional information regarding the cause of the phenomenon of caustic embrittlement has been obtained which may be so interpreted as to indicate the possibility that the present generally accepted theory regarding its development may be incorrect.

By way of elaborating upon this second and important result, which has developed in this investigation, it is possible to conclude that pure caustic soda (sodium hydroxide) apparently does not influence the failure of typical boiler steel under stress greatly below its tensile strength. It has been discovered in this investigation and subsequently by two other investigators working on the facts brought to light at New Brunswick, that typical boiler steel can be made to fail under tension at stresses somewhat beyond the yield point, but considerably below the tensile strength of the metal when in contact with a solution of caustic soda to which other salts, principally sodium silicate have been added. It would appear that this discovery opens up the whole problem of the cause of caustic embrittlement again. It serves also to give some credence to the opinion of those investigators and operators who have held that the generally accepted theory for the cause and prevention of caustic embrittlement was not correct and could not be applied to all failures of boiler metal exhibiting intercrystalline cracks predominantly.

With the problem thus again opened it is the belief of the Joint Research Committee that much information of great value will accrue to industry from the pursuit of the ideas resulting from this discovery. It is proposed that the mechanism by which sodium silicate or other salts influences intercrystalline attack on steel be thoroughly studied. It is felt that in so doing a clearer understanding of the development of the phenomenon will result and possibly more simple and satisfactory methods for combating its development may be discovered.

It has been estimated that at least two more years' work after June 30, 1936, and under the conditions under which the investigation is at present being done, will be required to answer the problem. The committee, however, does not care at this time to state specifically that the work will be satisfactorily completed within two years. On the basis of the experience of the three preceding years, it is estimated that the yearly cost of this investigation will be about $7500. With the present plans of the committee for the continuation of this work for two years more a fund amounting to $15,000 will be required.

Nine progress reports have been submitted to the subcommittee, of which all but Reports 6, 8 and 9 have been published and distributed to the contributors to the fund. Report No. 7 is scheduled for presentation at the Boiler Feed-Water Session of the A.S.M.E., December 5, 1936.

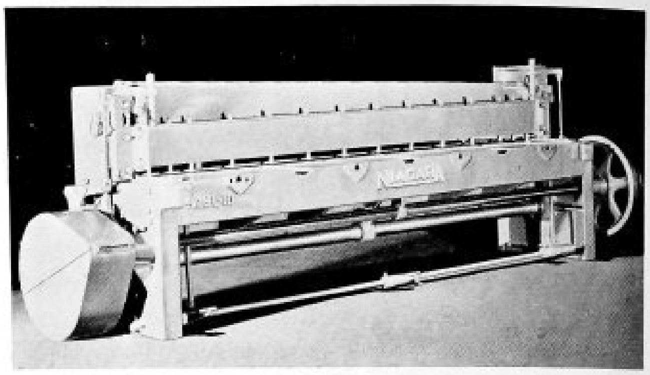
Power Squaring Shears

The Niagara Machine and Tool Works, Buffalo, N. Y., announces a new line of Series "BL" Power Squaring Shears built in 8, 10 and 12-foot cutting lengths. Rigid construction, accurate flat shearing, safety and convenient operation are claimed as a result of the modern design of these new shears.

They are of underdrive design; the crosshead is operated by connecting rods running direct from the eccentrics to the crosshead, thus relieving the housings of tension stresses. Heavy webbed beds are keyed and bolted to housings to assure and maintain positive alinement. The rear web of the bed covers the cross shaft, thus protecting the operator when removing sheared pieces at the rear.

The rigid triangular section steel crosshead resists torsional stresses in all directions and maintains alinement of the knife. An adjustable truss rod provides support for the center of the knife.

Sheets can be accurately cut to a line because the cutting line is clearly visible from the front of the shear between the pressure feet as well as from a position vertically above the cutting edge as observed through an adequate opening between the hold-down and the rearwardly sloping front web of the crosshead. This opening combined with the fact that the top of the hold-down bar is very low enables the operator to view his cut with ease and without strain. The crosshead has a low slope which results in flat cutting of narrow strips.



Underdrive type power squaring shears

The patented Niagara hold-down with individual spring pressure feet provides a firm grip on short as well as long sheets. The pressure feet are adjustable so that they are not dependent on striking the bed to limit their travel when the shear is operating idly. A cam and toggle mechanism accelerates the hold-down rapidly until it approaches the work, when it slows down, making a firm but soft engagement without severe impact. The cam and lever hold-down mechanism eliminates the transmission of stress to the cams, mainshaft or other moving parts during the cutting cycle.

The entire operating mechanism is protected from the sheared pieces. Gearing is outside the housing and enclosed in substantial steel guards. All gears and pinions are hob generated providing accurately formed tooth contact with resulting strength.

Cold-Rolled Steel with Tempered Properties

Full commercial production of "Armco Stabilized Steel" in cold-rolled sheets and strip has been announced by The American Rolling Mill Company, Middletown, O. Stabilized steel is offered by the company as a uniform, deep-drawing and non-aging cold-rolled steel with all stretcher strain permanently eliminated in the tempered condition. It retains indefinitely all of the properties of temper-rolled steel, making pre-fabrication treatments unnecessary, regardless of the length of time the metal has been in stock.

Unlike ordinary mild steels for deep drawing purposes, the new metal has no sharp yield point in the temper-rolled condition. It is superior in resistance to cracking in some very severe drawing operations, and it will retain its initial excellent drawing properties indefinitely, the company claims. In the general run of mild steel sheets, a sharp yield point develops within a comparatively short time after cold rolling, depending upon the aging temperatures to which they are subjected. It has been found that at 212° F. the "yield point elongation" increases continuously and reaches a maximum after about two weeks at this temperature. The same changes occur at room temperature, but require days instead of minutes for their consummation.

Manufacturers of products in which high finish deep drawing steel sheets are used have realized that aging in their plants has aggravated breakage and stretcher straining difficulties. Many users of drawing steel will be greatly interested in this development.

Work of the A.S.M.E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information on the application of the code is requested to communicate with the secretary of the committee, 29 West 39th St., New York.

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and published.

Following are records of the interpretations of this committee formulated at the meeting of April 24, and approved by the council.

Case No. 822 (*Interpretation of Par. P-301*)

Inquiry: May a lever-lifting type of gate valve be used as a blow-off valve under the requirements of Par. P-301?

Reply: It was the intent of the committee to permit the use of a lever-lifting type gate valve for blow-off purposes where quick-opening type valves are allowable. It is the opinion of the committee that lever-lifting type gate valves with operating mechanisms which require at least five 360-degree turns of the hand wheel to change from full-closed to full-opening and *vice versa* will meet the intent of a "slow-opening valve" as defined in Par. P-311.

Case No. 824 (*Special Rule*)

Inquiry: May a watertube boiler, having a total heating surface of not more than 300 square feet being a unit made up of sections, each section consisting of two seamless steel headers into which the connecting tubes are fusion-welded, be stamped with the code symbol if the material and welding meet the code requirements? The boiler is built without longitudinal or circumferential joints in the drum shell or headers.

Reply: It is the opinion of the committee that for this construction radiographic examination of the welds attaching the tubes to the headers is not required, and the boiler may be stamped as meeting the code requirements provided that:

(1) the tubes shall not exceed 2½ inches outside diameter;

(2) the welding of the tubes to the header complies with the rules for the attachment of nozzles;

(3) the header closures meet the requirements of Par. P-198;

(4) each section, consisting of two headers and connecting tubes, be stress relieved and the welds hammer tested; if two or more sections are attached to cross headers by fusion welding, the entire structure shall also be stress relieved as a unit and the joining welds be hammer tested;

(5) the hammer tests of all welds shall be made while under a hydrostatic test pressure of at least twice the working pressure;

(6) the protective and indicating devices meet the code requirements.

Case No. 825 (*Special Rule*)

Inquiry: May the front and back sheets of a staybolted box-type header for a water-tube boiler be joined together by fusion welding as indicated in Fig. 32?

Reply: It is the opinion of the committee that the

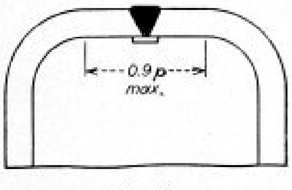


Fig. 32

construction covered by the inquiry may be used under the code rules provided that:

(1) the header is otherwise constructed in accordance with all the other rules of the code including staybolting;

(2) the staybolt pitch for flat surfaces containing welds does not exceed 90 percent of that permitted by Par. P-199;

(3) the welded joint is of the double-welded butt type or equivalent;

(4) the welds comply with all the requirements of Pars. P-101 to P-110 and Case No. 751, and the welded structure is stress relieved after the welding is completed, but before the staybolts are inserted.

Case No. 826 (*Special Rule*)

Inquiry: There is no provision in the Unfired Pressure Vessel Code for allowable pressures for steel tubes. What pressures may be used for such tubes in connection with unfired pressure vessels?

Reply: It is the opinion of the committee that the maximum allowable pressures in Tables P-2 and P-3 of the code may be increased by 100 lb. for use in unfired pressure vessels, and that the same applies to Table P-5 for tubes not to exceed 3 in. diameter.

Case No. 827 (*Interpretation of Par. P-331*)

Inquiry: When a plate is shipped to a fabricator or to a warehouse and is divided into two or more pieces, can such pieces, which carry no plate manufacturer's stamping, be stamped by the fabricator or warehouse?

Reply: It is the opinion of the committee that an authorized representative of a producer may duplicate the required mill stamping on any material wherever located. Plates at a warehouse not owned and controlled by the mill producing them, or plates in the hands of a fabricator may have additional stamping applied as provided in Par. P-331.

Case No. 828 (*Special Rule*)

Inquiry: Is it permissible under the Unfired Pressure Vessel Code to use nickel-clad material for fusion-welded vessels?

Reply: It is the opinion of the committee that unfired pressure vessels may be constructed of nickel-clad plates, provided that all code requirements covering the material of the base plates, welding, and tests for the class of service for which the vessels are intended, are complied with; the allowable pressure for the vessels is computed from the thickness of the base plates without any allowance for the nickel cladding; and that the completed weld or welds have a corrosion-resistant property substantially equal to that of the nickel cladding and such welds are completed before radiographing where this is required.

Bethlehem's new strip-sheet mill contains twenty-two acres of floor space

Bethlehem Company's new plant for

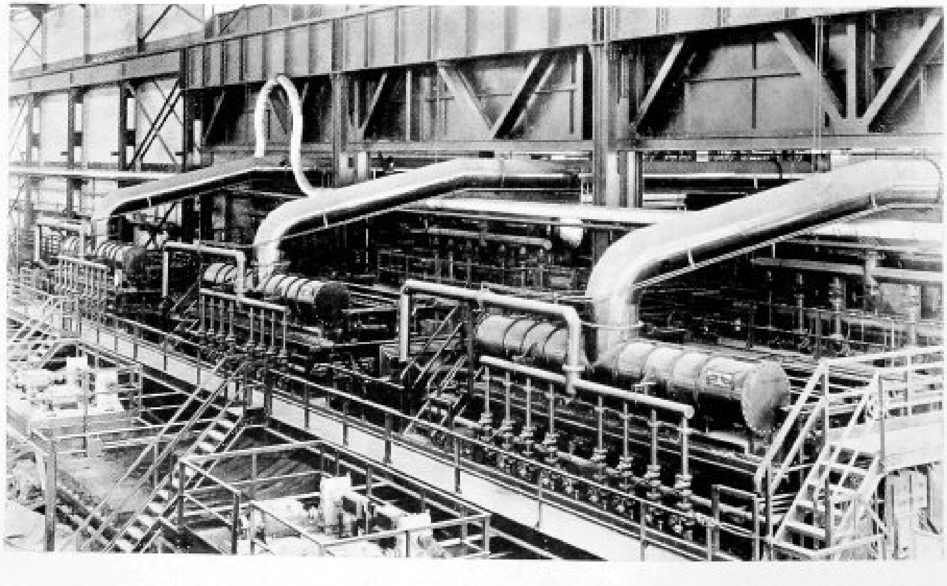
Producing Steel Strip and Sheet

On June 30 was held the formal opening of the Bethlehem Steel Company's $20,000,000 continuous strip sheet and light plate mill at Lackawanna, N. Y. With the completion of this mill the company has extended its facilities to cover the entire range of so-called flat-rolled products—plates, skelp, sheet bar, strip, sheets and tin plate. The adoption of rolling both hot and cold rolled sheets by the continuous method by the steel industry is said to have produced quality, accuracy and economy, which are daily opening new markets and replacing the old hand hot mill process.

Bethlehem's new continuous strip sheet and plate mill is built on a plot of 67 acres of ground adjacent to the Lackawanna plant, acquired for the purpose of providing ample space for the most ideal location of buildings, in order to make possible the most economic routing of materials and product through its 22 acres of floor space.

The mill has an annual capacity of 600,000 tons of strip, sheet, and light plate.

Wide strip up to 60 inches in width by 0.0625 inch in thickness or gage, and 72 inches in width by 0.078 inch in thickness, with a minimum width of 18 inches by 0.05



The heating furnaces accommodate 165 gross tons of slabs per hour for rolling in the hot-mill department inch in thickness, can be continuously hot rolled in one heating in the new Bethlehem hot mill.

Cold rolled strip is produced by Bethlehem in a range from 18½ inches to 72 inches wide and from 0.0125 inch in thickness for narrow widths up to 0.109 inch in thickness. By cross-rolling in the 93-inch 4-high skin pass mill sheets may be rolled up to 84 inches in width.

All possible refinements for hot rolled products, as well as for cold rolled sheet and strip for which there is any commercial demand, are provided, and at the same time the mill is equipped to roll and finish light plate up to one-half inch thick.

Throughout the mill buildings an atmosphere of spaciousness and orderliness prevails. Seen from the outside, the magnitude of the buildings is impressive. Once inside, the roominess of the well-ventilated and well-lighted interiors seems by comparison to dwarf the batteries of the huge rolling mills and the great furnaces. In the capacious storage and processing rooms, even in sections where machinery or piles of materials are most compact, there is no appearance of crowding.

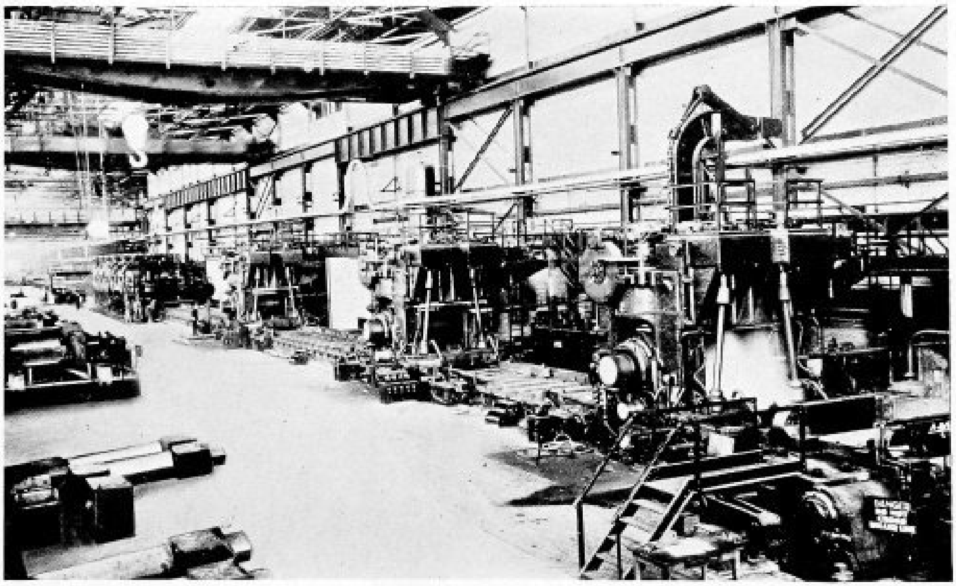
The slab storage building comes first in the sequence of operations; its floor throughout its 625 feet of length and 85 feet of width piled high with some 10,000 tons of slabs of various dimensions and chemical composition ready for heating and rolling as needed.

At the entering end of the hot mill department, between the slab storage yard and the hot strip rolling mill, are three large recuperative heating furnaces, built compactly together and yet with ample space between and around them for the control systems, automatic recording devices, and the operators who are watching these devices and provide the little supervision that is needed.

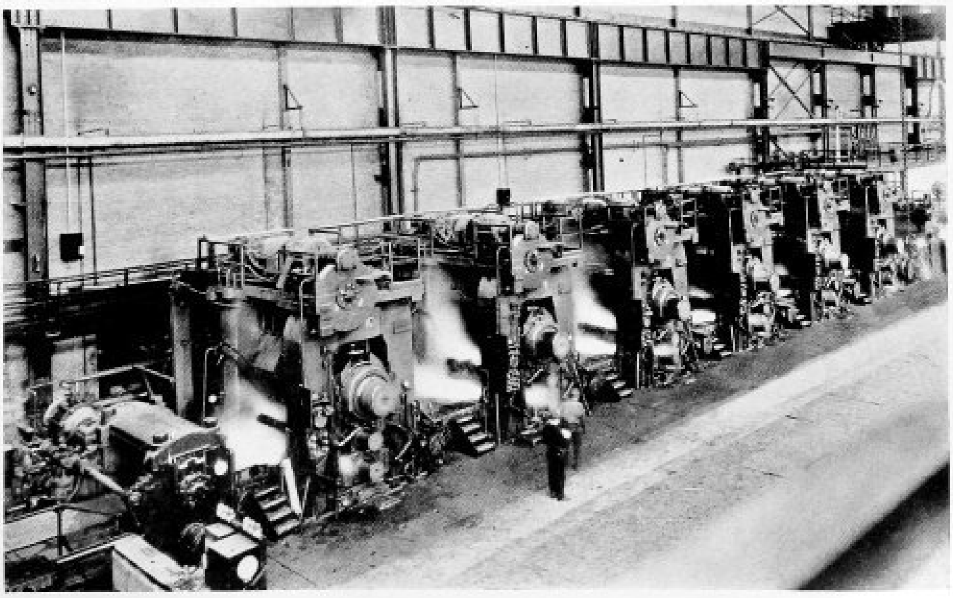
Entering the hot strip rolling mill building, the great 4-high rolling mills and the scale-breaking mills rise 20 feet from the floor, although the lower roll of the 4-high mills is located almost out of sight below the floor level. Even these seem relatively small in a building 75 feet high, with traveling cranes of 60 tons or more capacity moving about high overhead, and with the pickling room barely visible far down through the long finishing room in a vista 1800 feet away.

While it is in the hot strip rolling building that the mechanical dexterity of the whole plant is most striking,

Three of the mill stands of the roughing train with the finishing train of mills in the far background of the shop



Slabs elongated by the roughing train of mills enter this finishing train at slow speed and emerge in light gage steel strip form



Removable furnace tops each serve three annealing bases which are provided to handle material in both coil and sheet form

with the hot slab continually moving through rolling mills toward the automatic piling and coiling apparatus in the finishing building as if in response to the increasing pull of a powerful invisible magnet, the finishing and transfer processes in the finishing building, the plate building, and the storage and warehouse building also move ahead in rhythmic sequence. The three buildings, located side by side, are without interior side walls in order to facilitate transfer of material from one department to another. Their vast extent, 315 feet wide and ranging from 600 to 1050 feet long, supplies a perspective which makes the many workers seem small when viewed from the catwalks or the cranes overhead.

Spaciousness is the factor that again makes the chief impression in the adjacent buildings of the cold mill department. Following the order of processing, first comes the continuous pickling building, 105 feet wide and 950 feet long, one end filled with coils of strip in storage which will either go through the cold mills or be shipped direct to customers. At the other end are the continuous pickling lines, with the pickling tanks elevated some ten feet from the floor in order to permit the gravity conveyor to carry the pickled product from the end of the building, past the box-annealing furnaces, to temporary storage in the cold mill building adjacent to the batteries of the cold rolling mills set in tandem.

The three large buildings for cold rolling, processing and storage, and shipping stand side by side. These range from 575 to 1100 feet in length, and, with 315 feet of width, create a great open area interrupted only by steel framework and by machinery.

Walls, framework, traveling cranes, and machinery, wherever feasible, are painted with aluminum to provide all possible light. The floors of these buildings are paved with wooden blocks which deaden noise, and, together with the aluminum paint, the fine illumination and ventilation, combine to provide an attractive appearance and comfortable working conditions.

To get the quality of steel refinement needed for the many varying purposes to which it is put, a thorough understanding of heat treatment of metals is necessary. Bethlehem's experienced metallurgists have contributed their share in seeing that the right heat treatment and processing facilities have been provided at the new continuous strip mill so that the desired shape, arrangement, and character of granular structure may be obtained.

While the plant's mechanical processes move along smoothly and generally at great speed, and always with a minimum of human direction to produce material of predetermined characteristics, nevertheless what happens in each operation is constantly checked and tested by specialists to insure to the customer the grade of finished product which will meet his precise requirements.

Hot Mill Department

In order to start slabs on their way through the mills the head roller, standing at the No. 10 finishing mill, presses a button which blows a siren. In turn, the operator standing at the beginning of the production line near the first scale breaker adjacent to the heating furnaces sounds two blasts on a whistle. The operator on a control pulpit, located in the slab storage building, then turns on a switch which (1) sets the slab pusher in motion, and (2) through an electrically interlocked mechanism starts the motor on a door-lifting device at the furnace's discharge end, over 100 feet away from the control pulpit, thus ejecting a heated slab to take its place on the roller table ready for its entrance into the No. 1 scale breaker.

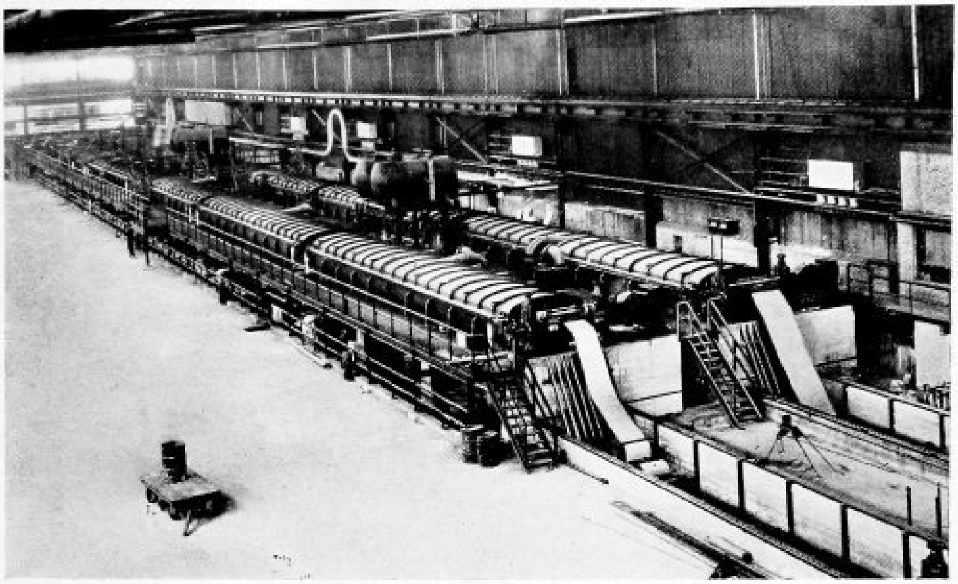
When a large number of slabs are to be rolled of the same width and gage of strip, the system of signaling by siren and whistle is not required. These signal devices are used only if, for any reason, it becomes necessary to slow down or stop the rolling. When these signals are not used, the operator in the control pulpit in the slab room releases heated slabs at predetermined fixed intervals.

By reversing the direction of the rolls on the roller table in front of the furnace, heated slabs may be discharged on to a transfer car and returned to the slab storage room.

The three furnaces for heating slabs, like all the machinery in the new plant, are the most modern and efficient which Bethlehem's engineers could find. They are of the recuperative type, 3-zone and triple-fired. The furnaces have an effective heating length of 80 feet and an inside width of 18 feet, with a 16-foot 9-inch soaking hearth.

Each furnace is so arranged as to heat slabs up to 16 feet in length in a single row, or up to 7 feet 6 inches in two rows. Widths may vary from 18 to 50 inches. Each furnace, when being charged with steel at atmos-

Two continuous pickling lines are provided in the new plant to replace the conventional hand-mill method of pickling generally employed in most rolling mills



pheric temperature, will heat 50 gross tons per hour, plus a 10 percent additional amount when charging two rows 7 feet by 6 inches long, or a single row 16 feet long. This makes a maximum capacity for the three furnaces of 165 gross tons per hour of cold steel.

The heated slab leaves the furnace at a temperature of close to 2250 degrees F. as it proceeds down the roller table, starting out perhaps seven and one-half feet long, four feet wide, and five inches thick. It first approaches a scale-breaking stand in front of a series of four mill stands in the roughing train. This scale-breaking stand consists of two rolls, 24 inches in diameter and 76 inches long, through which the slab is forced and given a slight reduction in thickness, to break up any scale or oxide that may be on the outer surfaces of the slab as it leaves the furnace.

The slab is now ready for the heavy reductions it gets in the roughing mills. It first enters a 4-high broad-side mill, passing between two rolls, 36 inches in diameter and 96 inches long, backed up on top and bottom by two rollers of the same length, but 49 inches in diameter.

Slabs which are to emerge from the finishing mills as strip sheet not over 48 inches wide pass through this broadside mill without a halt. If, however, a strip width greater than 48 inches is to be produced, the slab is turned crosswise on turntables and is cross-rolled from the slab width to the required strip width, after which it is turned back 90 degrees for rolling lengthwise on the remaining mill stands.

Leaving the broadside mill, the slab enters a slab squeezer, which serves to true and square its side edges before entering the remaining three mills of the roughing group. The last three mills have working rolls 24½ inches in diameter and 79 inches long, and backing rolls of the same length and 49 inches in diameter.

The slab squeezer not only squeezes the slab sideways, so as to insure evenness of its edges, but also exerts pressure downward, so that the slab also will be even in thickness.

As the slab leaves the slab squeezer and enters the next roughing mill it moves rather slowly,—at a rate of not over 50 feet a minute,—but as it receives a heavy reduction in each mill its length increases rapidly and its movement is accelerated until it leaves the last mill of the roughing group at 410 feet a minute.

As the slab approaches mills Nos. 2, 3, and 4 of the roughing train, water is forced on it at 1000 pounds pressure to clean off any oxide or surface dirt that may have accumulated since the previous reduction. This spraying is in addition to the thorough cleansing by high pressure water after the slab leaves the scale-breaking machine. At the No. 4 stand in the roughing train steam is also blown on the slab to remove dirty water and scale.

The slab has now been reduced approximately to one-fifth of its original thickness, i.e., to somewhere between ⅝ and 1¼ inches. It next passes over a roller table about 95 feet long, leading to the finishing group of mills.

As the slab progresses down this roller table the operator, who keeps his eyes on the pyrometer, controls the speed of the slab movement, retarding its progress if the metal is still too hot, or, if necessary, reversing the direction of the movement for a moment or two until the indicator on the pyrometer shows that the temperature has dropped to the right point—between 1900 degrees and 1950 degrees F.

The slab now enters a second scale-breaking stand and again is subjected to a water spray at 1000 pounds pressure to remove oxide that has formed during the journey from the last roughing mill. Next the slab passes to a flying crop shear, which cuts off its uneven ends, formed in the roughing train, which otherwise would mar the finely polished rolls of the finishing mills.

The transition from slab form to strip now takes place.

From this point on the really rapid action begins. The strip passes through six 4-high finishing stands, with inner working rolls 24½ inches in diameter, outer rolls 49 inches in diameter, and all of them 79 inches in length. At each stand the strip is reduced about one-third in thickness and greatly increased in length, and may, for instance, emerge from the last finishing stand one-twentieth of an inch thick, over 1100 feet long.

As in the roughing mills, so in the finishing mills, every precaution is taken during the rolling to eliminate scale and dirt. Here steam instead of water is sprayed on the rapidly thinning strip just after it passes through each set of rolls. As it leaves the last finishing mill the rapidly moving strip may be cut to any predetermined length from 8 feet up to 25 feet by a flying shear synchronized with the speed of the strip, or if the strip is to be coiled, the flying shear may be used to cut off the front end as it emerges from the mill train.

As it leaves the finishing mills the strip moves on straight ahead either to the hot strip coilers or to the hot sheet pilers.

In the production of hot rolled strip it is important to secure the desired grain structure, which is controlled by the temperature of the strip as it leaves the finishing mill train. To indicate the temperature at which the strip leaves the mill a temperature-recording ardometer has been installed and placed within view of the operator. This finishing temperature is maintained above the upper critical, so that no cold working takes place in the hot rolling, and consequently an anneal is unnecessary if any of the product is to be further reduced by cold rolling. Hot strip which is to be cold rolled is usually finished on the hot mills at slightly above the upper critical, and is cooled down to approximately the lower critical on its travel to the cooler, resulting in a small uniform grain structure, proper for starting the cold reduction in the cold mills and the subsequent treatments.

Since hot rolled strip is rolled singly and in great lengths, the speed at which it leaves the finishing stand must necessarily be high. The speed varies from 676 to 1352 feet a minute, depending upon the gage being finished—the thinner gages necessitating the higher speed. A single piece of strip 0.0625 inch in thickness and in widths under 48 inches will approximate 1150 feet in length, whereas in widths greater than 48 inches it will reach up to 500 feet.

As the strip moves down the roller tables in the finishing building at a high speed it is kept headed straight and in the center without the use of side guards, by the concavity of the rolls themselves, most pronounced at their center.

Hot strip to be manufactured in sheet or flat form moves down the roller table to one of two sheet pilers, the first of which is located about 300 feet beyond the finishing mill and is intended for the piling of hot sheets in packs of the lighter gages of material for self-annealing. The second piler is used for the heavier gages of strip product, which requires more time to cool.

The most important function of cold rolling is reduction to lighter gage than can be economically hot rolled. Furthermore, for many uses strip-sheet steel must be refined beyond the stages provided by the facilities of the hot mill department. For example, such treatments include a thorough pickling to remove all impurities from the surface of the metal. To obtain the highest grade of ductility, to permit deep drawing of sheets while being formed for many purposes, and to improve the grain structure of the strip metal after going through the hot rolling process, careful heat treatment in box-annealing furnaces is required. After these treatments have been given the strip sheet must be rolled in the skin pass mills and undergo a very slight reduction to give the thin sheets a finely polished surface and for the tempering effect.

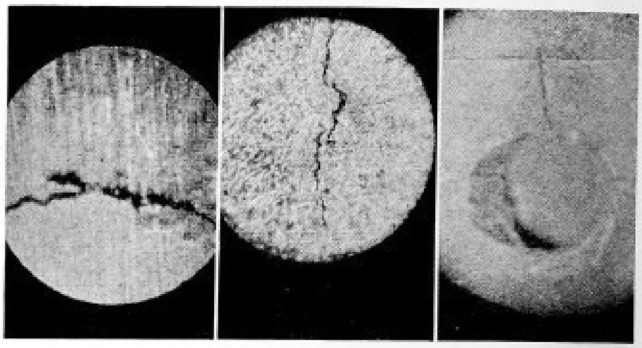
These cold rolling and corollary operations are carried out without back tracking with the same continuous flow of material as in the hot mills.

Cold rolled strip has a more accurate thickness and a more definite degree of hardness than can be achieved by hot rolling, and presents a better polished, glossier surface. Because of the heavy cold reduction in particular its elastic limit is on the average higher than that of sheets produced on the conventional hand mill, which gives it a distinct advantage when used for many types of difficult stampings.

Complete facilities for taking strip sheet through various processes with the utmost convenience and the least possible delay have been provided in a set of five main cold mill buildings.

Embrittlement in a Power Boiler*

On inspecting a power boiler at a Mid'west plant, for insurance, the inspector discovered a leaky seam which showed evidence of having been calked repeatedly in a fruitless effort to make it tight. He noticed, too, that several new rivets had been driven in the seam. Inquiry developed the information that the seam had been giving trouble for some time and that rivet heads had been found broken off from time to time. As



Left—crack which caused the leakage. Center—the crack at the left as it appeared in the rivet hole. Right—characteristic embrittlement cracks with which the plate was affected

these symptoms pointed to the probable existence of serious distress, the inspector took steps to verify his suspicion. His investigation led to the discovery of a case of plate embrittlement which had progressed to a dangerous degree.

The boiler was of the bent tube type, and of medium size. Its seams were of double-riveted lap construction. The leakage came from a crack in the plate under the lap of the longitudinal seam and since it did not extend beyond the calking edge of the seam, its presence would not have been suspected by one not conversant with this type of failure. Each time the seam had been recalked the defect had progressed and further leakage had been increasingly difficult to stop. When the drum was examined in detail, the seam was found to be seriously weakened for most of its length by a multitude of embrittlement cracks. A test of both the raw and the treated feed water showed that either could have led to the development of the condition.

New Coated Welding Electrode

An entirely new line of coated rods for direct-current welding is now being made and sold through the Harnischfeger Corporation, Milwaukee, manufacturers of P&H-Hansen arc welding equipment. The present line includes five different types with both high and low rates of fluidity for various types of work in welding in flat, vertical or overhead positions and with ferrous and non-ferrous metals. Service tests show tensile strength of welds from 55,000 to 75,000 pounds per square inch with various types of rods ranging from 3/32 inch to 3/8 inch in size. Smootharc electrodes are designed primarily to speed up welding operations with a smoother, more easily handled arc and to reduce spatter losses.

* *The Locomotive*, Hartford Steam Boiler Inspection and Insurance Company.

Practical Plate Development—XV

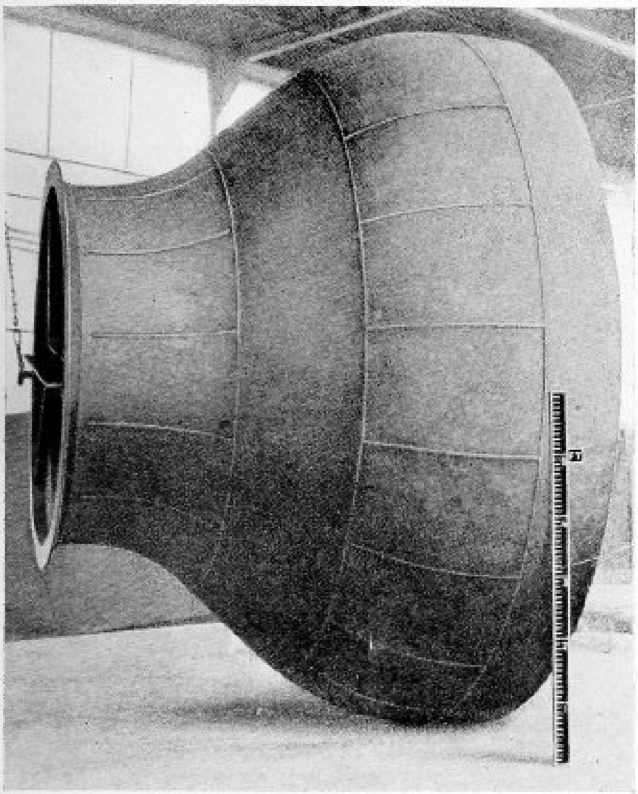


Fig. 129—This wind tunnel section is a challenge to the layerout

Wind Tunnel for Aircraft Experimental Work

By George M. Davies

An illustration of the section of the wind tunnel to be developed is shown in Fig. 129.

The section consists of a reduction piece for reducing the diameter of the tunnel and consists of three distinct parts, the large end where the sections are belled out as in forming an hemispherical head, the small end where the sections are inverted or belled in, and the center piece which consists of a conical connection between the end sections.

The section of the wind tunnel shown in Fig. 129 is of all-welded construction with butt-welded joints. The end sections consist of a series of gores formed or pressed into shape and welded together. These gores are made identical with each other so that it will only be necessary to show a development of one gore at each end. In making a development of these gores, first, lay out the elevation as shown in Fig. 130, using the neutral axes of the plate in laying out the outline of the tunnel section as shown.

The first development to be considered will be that of one of the sections or gores of the large end. Draw the end view, Fig. 131, and divide the circumference of the large end into the same number of equal parts as there are sections or gores decided upon, which, in this case is sixteen. The greater the number of sections taken, the less will be the variation in the individual gore due to forming or pressing into shape. Next connect these points with the center O cutting the diameter of the small end of the section and dividing the end view into sixteen equal parts. Number one of the parts P-Q-R-S as shown.

Then in the elevation divide the arc E-C into any number of equal parts, the greater the number of equal parts taken the more accurate the final development. In this case, four parts are taken and the intersections numbered from 1 to 5 as shown. Next, parallel to the line A-C, draw lines through the points 1 to 5 extending same through the elevation cutting the center line at the points 1′ to 5′ as shown.

Then with O in the end view, Fig. 131, as a center and with the trams set equal to 1-1′ of the elevation as a radius, scribe a circle, cutting the lines P-Q and R-S at a. With the same center and with the trams set equal to 2-2′ of the elevation as a radius, also scribe a circle, cutting the lines P-Q and R-S at b. In like manner using 3-3′, 4-4′ and 5-5′ of the elevation as radii scribe circles cutting the lines P-Q and R-S at the points c, d and e respectively.

Then parallel to the center line O-F draw lines through the points a in the end view extending same into the elevation cutting the line 1-1′ at a′. In like manner draw lines through the points b, c, d and e of the end view, extending same into the elevation cutting the lines 2-2′, 3-3′, 4-4′, 5-5′ respectively, locating the points b, c, d and e in the elevation. Connect the points a′-b′-c′-d′-e′ on both sides of the center line O-F, completing the section P′Q′R′S′ in the elevation. Next bisect the arc E-C and draw the line O′-M cutting the arc at N. At N erect a perpendicular to O′-M extending same to cut the center line O-F at K. Extend K-N cutting A-C at EE.

The development of the pattern of the gores for the large end is shown in Fig. 133. Draw any line as T-U and with U as a center and with the trams set equal to the distance K-EE in the elevation scribe an arc cutting T-U at 5″. Then from 5″ step off the distances 5″-4″, 4″-3″, 3″-2″, 2″-1″ equal to the distances 5-4, 4-3, 3-2, 2-1 of the elevation respectively.

Then with U, Fig. 133, as a center and with the trams set equal to U-5″, U-4″, U-3″, U-2″ and U-1″ scribe arcs extending same each side of the line T-U.

Next from the end view, Fig. 131, take the distance from the center line O-V to the point e measured on the arc and step off same each side of the center line T-U on the arc drawn through 5″ locating the points e′ on both sides of T-U. In like manner take the distance from the center line O-F to the points d, c, b and a of the plan view and step off same each side of the center line T-U on the arc drawn through the points 4″, 3″, 2″ and 1″ respectively. Connect the points a′, b′, c′, d′, e′ on each side of the line T-U completing the pattern of the gore for the large end of the tunnel. Sixteen of these gores will complete the large end of the tunnel section.

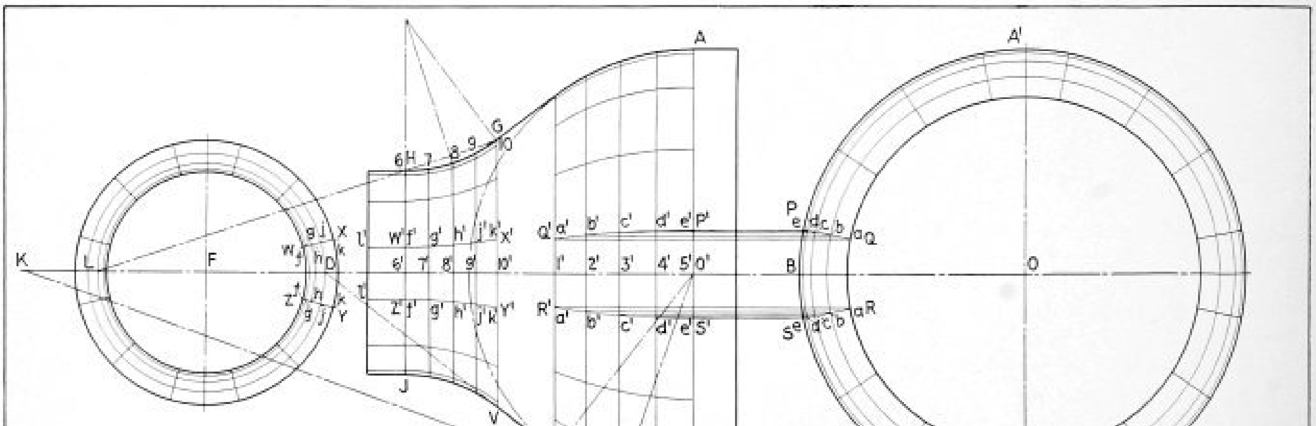
The next development to be considered will be that of one of the sections or gores of the small end of the tunnel. Draw the end view, Fig. 132, and divide the circumference of the large end into the same number of equal parts as are sections or gores decided upon; which is twelve in this case. The greater the number of sections taken the less will be the variations in the individual gore due to forming or pressing into shape. Connect these points with the center F, cutting the diameter of the small end of the section and dividing the end view into twelve equal parts. Number one of these parts W-X-Y-Z as shown.

In the elevation divide the arc H-G into any number of equal parts, the greater the number of equal parts taken the more accurate the final development with four parts being taken in this case. Number the intersections from 6 to 10 as shown. Next, parallel to the line H-J, draw lines through the points 6 to 10, extending same through the elevation cutting the center line at the points 6′ to 10′ as shown.

Then with F in the end view, Fig. 132, as a center and with the trams set equal to 6-6′ of the elevation as a radius, scribe a circle, cutting the lines W-X and Y-Z at f, then with the same center and with the trams set equal to 7-7′ of the elevation as a radius scribe a circle, cutting the lines W-X and Y-Z at g. In like manner, using 8-8′, 9-9′ and 10-10′ of the elevation as radii, scribe circles cutting the lines W-X and Y-Z at the points h, j and k respectively.

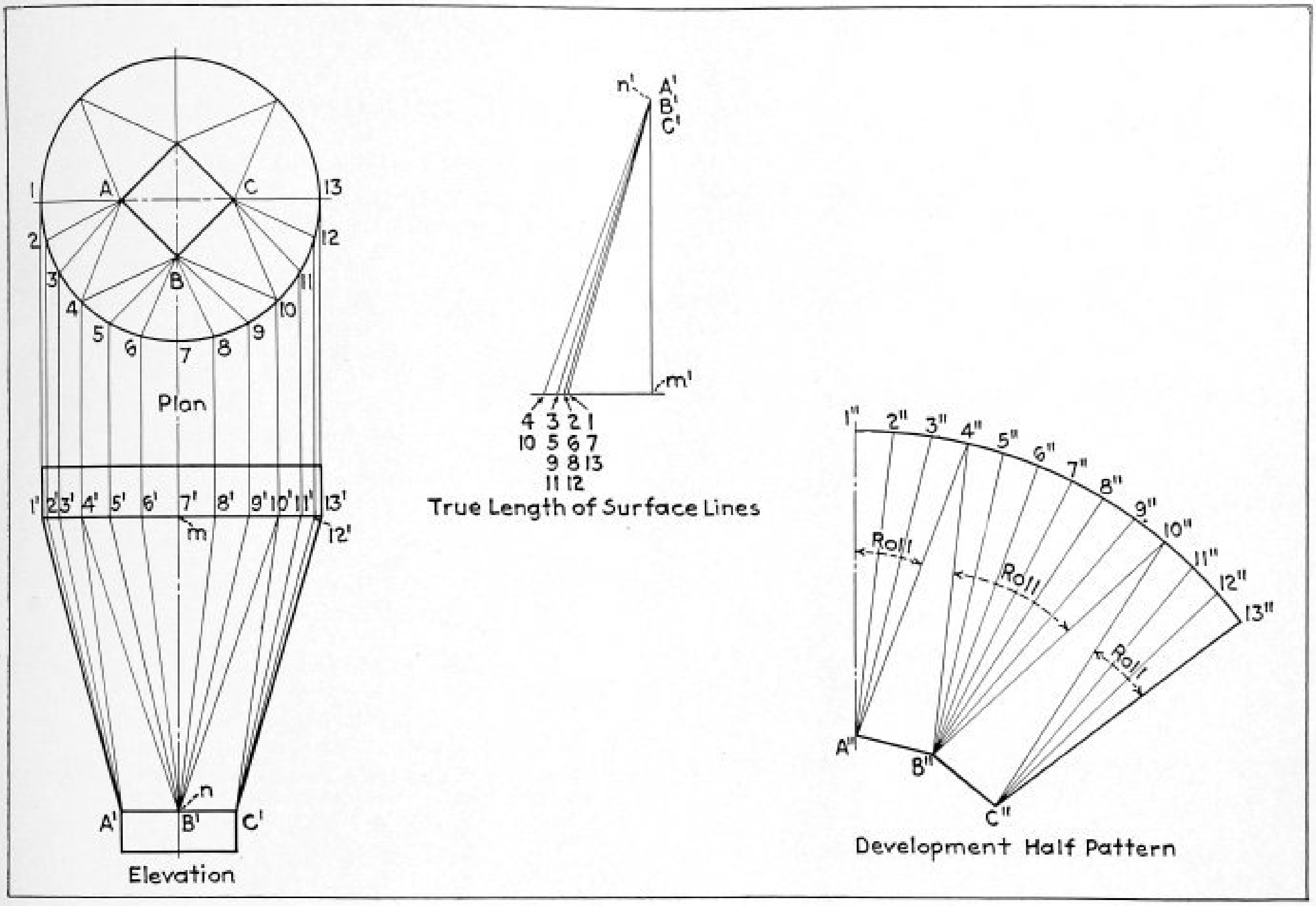
Next, draw lines parallel to the center line F-O, through the points f in the end view extending same into the elevation cutting the line 6-6′ at f′. In like manner draw lines through the points, g, h, j and k of the end view, Fig. 132, extending same into the elevation cutting the lines 7-7′, 8-8′, 9-9′ and 10-10′ respectively and locating the points g′, h′, j′, k′ in the elevation. Connect the points f′, g′, h′, j′, k′ on both sides of the center line F-O and completing the section W′-X′-Y′-Z′ in the elevation. Next draw the line H-G extending same cutting the center line F-O at L.

The development of the pattern of the gores for the small end is shown in Fig. 134. Draw any line as AA-BB and with B-B as a center and with the trams set equal to the distance L-G in the elevation scribe an arc



Details of layout for wind tunnel section

Problem No. 11—Correct Layout



Problem No. 11, an irregular-shaped hopper, appeared on page 128 of the May issue. Above is the correct method of laying out this problem and may be used as a check against the method used by readers who have attempted a solution of the problem

cutting the line AA-BB at 10″. Then from 10″ step off the distances 10″-9″, 9″-8″, 8″-7″, 7″-6″ equal to the distances 10-9, 9-8, 8-7, 7-6 of the elevation respectively.

Then with B-B, Fig. 134, as a center and with the trams set equal to BB-10″, BB-8″, BB-8″ BB-7″ and BB-6″ scribe arcs extending same each side of the line AA-BB.

Next from the end view, Fig 132, take the distance from the center line F-O to the point k measured on the arc and step off same each side of the center line AA-BB on the arc drawn through 10″, locating the points k′ on both sides of AA-BB. In like manner take the distance from the center line F-O to the points j, h, g and f of the plan view and step off same each side of the center line AA-BB on the arc drawn through the points 9″, 8″, 7″, 6″ respectively. Connect the points f′, g′, h′, j′, k′ on each side of the line AA-BB completing the pattern of the gore for the small end of the tunnel. Then to this pattern add the straight portion, making l′-f′, Fig. 134, equal to l′-f′, Fig. 130 and making the arch l′-l′, Fig. 134, the same radius as the arc f′-f′. Twelve of these gores will complete the small end of the tunnel section.

To develop the conical section, in the elevation extend the side V-E of the conical section cutting the center line F-O at D. Then draw any line as CC-DD, Fig. 135, and with CC as a center and with the trams set equal to the distance D-E in the elevation scribe an arc extending same each side of the center line CC-DD, and again with CC as a center and with the trams set equal to D-V of the elevation scribe an arc extending same each side of the center line CC-DD.

On the outside arc step off the distances B′-C′ and B′-A′ equal in length to B-C′ and B-A′ of the plan view, Fig. 131. Connect the points A′ and C′ with the center CC which will complete the half pattern as shown. A duplicate of this pattern will complete a full pattern of the conical section.

(To be continued)

Long Distance Record Made in Boiler Explosion

To the French railways goes a record of which they can hardly be proud. In a recent boiler explosion on the locomotive of a passenger train at Tenay-Hautville, the running gear was left on the track, while the rest of the engine was blown into a cornfield exactly 1738 feet away. This must be a long distance record for boiler explosions.

American Welding Society to Meet

The American Welding Society will hold its seventeenth annual meeting at Cleveland, October 19 to 23. Headquarters for the technical sessions and committee meetings will be at the Hotel Cleveland. Simultaneously the Metal Congress Exposition will be held at the Public Auditorium.

A complete and interesting program for the meeting has been arranged tentatively as follows:

Monday, October 19

Morning

9:45 A.M. Ball Room—Business Session.
President J. J. Crowe presiding.
Report on Society Activities by President Crowe.
Teller's Report on Election of Officers.
Award of Samuel Wylie Miller Memorial Medal.
Review of Committee and Section Activities by Chairmen.
Discussion.

Afternoon

2:00 P.M. Ball Room—Technical Session.
A. E. Gibson, *Chairman,* The Wellman Engineering Company.
E. Vom Steeg, *Vice-Chairman,* General Electric Company.
Welcome address by local official.
"Fundamentals of Metallurgy of Welding," by E. S. Davenport and Dr. R. H. Aborn, United States Steel Corporation.
"Multi-Layer Oxy-acetylene Pipe Welding," by R. M. Rooke, F. C. Saacke and A. N. Kugler, Air Reduction Sales Company.
High speed motion pictures of various welding processes, by E. Vom Steeg, General Electric Company; W. E. Crawford and Walter Richter, A. O. Smith Corporation.

Evening

6:30 P.M. Parlor—Dinner and Meeting Board of Directors.
Review of Society Activities, appointment of committees and officers, new business.

Tuesday, October 20

Morning

9:45 A.M. Ball Room—Technical Session.
H. M. Boylston, *Chairman,* Case School of Applied Science.
E. R. Fish, *Vice-Chairman,* The Hartford Steam Boiler Inspection and Insurance Company.
Fundamental Research in Welding
"Heating by the Proximity Effect," by Edward Bennett, The University of Wisconsin.
"The Welding of Copper," by A. P. Young, Michigan College of Mining and Technology.
"Non-Destructive Testing of Welds," by W. B. Kouwenhoven, The Johns Hopkins University.
"Impact Tests of Welds at Low Temperatures," by Otto Henry, Brooklyn Polytechnic Institute.

Afternoon

2:00 P.M. Ball Room—Technical Session.
H. W. Gillett, *Chairman,* Battelle Memorial Institute.
R. E. Kinkead, *Vice-Chairman,* Consulting Engineer.
Fundamental Research in Welding
"X-Ray Methods for Studying Stress Relief," by John T. Norton, Massachusetts Institute of Technology.
"Welded Beam-Column Connections," by Inge Lyse, Fritz Engineering Laboratory, Lehigh University.
"Circuit Characteristics and Arc Stability," by S. C. Osborne, Wilson Welder and Metals Company, Inc.
"Welded Structural Brackets," by C. D. Jensen, Lehigh University.

Evening

7:30 P.M. Conference and Meeting of Fundamental Research Committee, Bureau of Welding Research and Engineering Foundation.
H. M. Hobart, *Chairman,* General Electric Company.
This conference is scheduled for university research workers in the fundamentals of welding.

Wednesday, October 21

Morning

9:45 A.M. Ball Room—Technical Session.
A. F. Davis, *Chairman,* The Lincoln Electric Company.
C. A. McCune, *Vice-Chairman,* Magnaflux Corporation.
"Brazing with Silver Solders," by Robert H. Leach, Handy & Harman.
"Importance of Design Control for Welded Piping Systems," by T. W. Greene, Linde Air Products Company.
"Principles of Surfacing by Welding," by E. W. P. Smith, The Lincoln Electric Company.
"Technique for Resistance Welding Ferrous and Non-Ferrous Sheet Metals," by E. I. Larsen, P. R. Mallory Co.

Afternoon

2:00 P.M. Ball Room—Technical Session.
Hugh H. Dyar, *Chairman,* The Linde Air Products Company.
J. B. Tinnon, *Vice-Chairman,* Metal and Thermit Corporation.
"Procedures for Control of Welding Parts," by G. H. Moore, Jr., Newport News Shipbuilding and Dry Dock Company.
"Welding Copper and Its Alloys—A Review of the Literature," by Ira T. Hook, American Brass Company.
"Resistance Welding of Dissimilar Metals," by R. T. Gillette, General Electric Company.
"Thermit Welding," by J. H. Deppeler, Metal & Thermit Corporation.
"The Exploration of the Modern Metallic Arc," by L. J. Larson, A. O. Smith Corporation.

Thursday, October 22

Morning

9:45 A.M. Joint Session American Welding Society with American Society of Mechanical Engineers.
C. W. Obert, *Chairman,* Union Carbide & Carbon Research Laboratories, Inc.
Milton Male, *Vice-Chairman,* United States Steel Corporation.
"Stress Analysis," by C. H. Jennings, Westinghouse Electric and Manufacturing Company.
"Alloy Steels and Their Weldability," by A. B. Kinzel, Union Carbide and Carbon Research Laboratories.

Afternoon

2:00 P.M. Joint Session American Welding Society with American Society of Mechanical Engineers.
H. F. Henriques, *Chairman,* Air Reduction Sales Company.
S. M. Weckstein, Vice-Chairman, Timken Roller Bearing Company.
"Welding Heavy Machinery and Equipment," by C. A. Wills and F. L. Lindemuth, Wm. B. Pollock Company.
"Steel Plate Construction."
"Using Steel Plates for Machine Frames."

Evening

7:00 P.M. Dinner dance with entertainment.

Friday, October 23

Morning

American Society of Mechanical Engineers
(American Welding Society members invited)
Weldability of Non-Ferrous Metals:
Copper, Brass and Bronze, Monel Metal, Aluminum.

Afternoon

American Society of Mechanical Engineers
(American Welding Society members invited)
Review of Welding Developments as they affect Mechanical Design.
Welding of Light Machines and Products.
Principles Involved in Selecting Casting *vs.* Welding.

Lee W. Tremblay, Witherspoon Building, Philadelphia, has been appointed sales representative for The Edward Valve & Mfg. Company, Inc., East Chicago, Ind., builders of valves for high pressures and temperatures.

Locomotive Inspector's Examination

John M. Hall, chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission, has announced recently that the United States Civil Service Commission will hold an open competitive examination, entitled Inspector of Locomotives, $4000 a year, for the position named. The examination will be held in the near future at a large number of points located throughout the country. Vacancies in this position in the field and positions requiring similar qualifications will be filled from this examination, unless it is found in the interest of the service to fill any vacancies by reinstatement, transfer or promotion. The salary specified is subject to a 3½ percent deduction retirement annuity.

The duties required of a locomotive inspector will be to personally inspect locomotives and see that carriers make inspections in accordance with the locomotive inspection law and the rules and regulations established thereunder, and that carriers repair any defects which such inspections may disclose before the locomotives or appurtenances thereof are again put in service; to investigate any accidents caused by failure of any parts or appurtenances of the locomotive or tender resulting in damage, injury or death, and to perform other work as assigned. The duties of a locomotive inspector require that the appointee be of good moral character and habits, active, intelligent and discreet, of good speech and manner, qualified to address and confer with railroad officials as occasion may demand.

Subjects and Weights.—Competitors will be rated on the following subjects, which will have the relative weights indicated:

Subjects	Weights
1. Arithmetic (fundamental operations, common and decimal fractions, and simple percentage)	5
2. Locomotive boilers and appurtenances (practical questions relating to construction, testing, inspection, repair, and operation)	25
3. Locomotives, tenders, and appurtenances (practical questions relating to construction, testing, inspection, repair, and operation)	25
4. Report writing (a report of not less than 200 words on a given case relating to the duties of an inspector of locomotives)	25
5. Experience in railroad work and general fitness	20
Total	100

Time Required.—One day of six hours and a second day of seven hours will be required for this examination.

Ratings Required.—In each of Subjects 2, 3, 4, non-preference competitors must attain a rating of at least 70, competitors granted military preference a rating of at least 65, excluding preference credit, and competitors granted disability preference a rating of at least 60, excluding preference credit. In addition, all competitors must attain in the whole examination an eligible average of at least 70, including preference credit, if any.

Report Writing.—As inspectors are required to report in writing the results of their investigations, they must be qualified to make reports which shall be not only comprehensive, but also correctly, logically, and concisely expressed. In rating this subject, not only will attention be given to the technical and practical knowledge displayed, but special consideration will be given to correct phraseology, grammar, construction, coherence, and effectiveness of expression.

Applicant's Qualifications

1. They must be citizens of the United States.

2. *Experience.*—They must have had not less than six years' experience with railroads operating as common carriers coming within the scope of the Locomotive Boiler Inspection Act, as amended, in the capacity of master mechanic, road foreman of engines, roundhouse foreman, shop foreman, locomotive engineer, locomotive boiler maker, locomotive boiler inspector, or locomotive machinist; or not less than eight years as railroad locomotive inspector or locomotive fireman. They must have had at least six months' active service in any capacity named above, or in connection with the inspection of locomotive equipment under the Government of the United States or of any State or Territory thereof, within three years next preceding the closing date for receipt of applications, or within four years if the applicant's railroad service terminated by furlough because of reduction of force.

The experience herein required must be in addition to the time served in apprenticeship or spent attending a technical school.

No person interested either directly or indirectly in any patented article required to be used on any locomotive coming under the supervision of the Interstate Commerce Commission, and no person who is intemperate in his habits, will be eligible for appointment.

3. *Age.*—They must have reached their twenty-eighth but not their fiftieth birthday on the date of the close of receipt of applications. These age limits do not apply to persons granted preference because of military or naval service, except that such applicants must not have reached the retirement age.

4. *Physical Ability.*—Applicants must be in sound physical health. Remediable defects or curable disease will not exclude a person from examination, but proof that such defects have been remedied, or the disease, if any, cured, must be received during the life of the eligible register before persons otherwise qualified may be considered for appointment under civil-service rules. Persons selected for appointment will be required to pass a physical examination given by a Federal medical officer. Failure to pass such physical examination will prevent appointment.

Applicants must file the following with the United States Civil Service Commission, Washington, D. C., not later than July 20, 1936.

1. Application Form 6 and Supplementary Form 3237, both properly executed.

2. Applicants who wish to claim veteran preference must file Preference Form 14 (blue) properly executed and accompanied by the documentary proof required therein.

3. Foreign-born applicants must submit with their applications proof of United States citizenship.

Photographs.—Applicants must submit to the examiner on the day of the examination their photographs, taken within 2 years, with their names written thereon, and securely pasted in the space provided on the admission cards sent them after their applications are filed. Proofs or group photographs will not be accepted. Photographs will not be returned to applicants.

Oral Examination.—Applicants may be required to report for oral examination, which will be held at points as convenient for them as conditions will permit. The purpose of the oral examination is to determine the applicant's personal characteristics, his address, adaptability, keenness of perception, observation, judgment, and discretion; in general, his personal fitness for the performance of the duties of the position. Applicants who fail to pass the oral examination will not be eligible for appointment. The oral examination will be given to applicants in the order of their standing and only to such number as the needs of the service may require. Notice will be given in advance of the date and place of the oral examination. Any traveling expenses incurred by an applicant in connection with the oral examination must be borne by him.

Certification.—Certification to fill positions will be made of the highest eligibles on the register from the entire country who have not expressed unwillingness to accept appointment where the vacancy exists, except that certification may be made of the highest eligibles examined in the inspection district in which the appointee is to be employed, provided that satisfactory evidence is presented to the Commission showing that the needs of the service will be better met by such restricted certification. The department or office requesting certification of eligibles has the legal right to specify the sex desired. For this position the Interstate Commerce Commission wishes men.

Fingerprints.—Fingerprints will be taken of all persons appointed from this examination.

Application Forms.—The necessary forms may be obtained from the *Secretary, Board of U. S. Civil Service Examiners, at any first-class post office,* from the United States Civil Service Commission, Washington, D. C., or from United States Civil Service district offices.

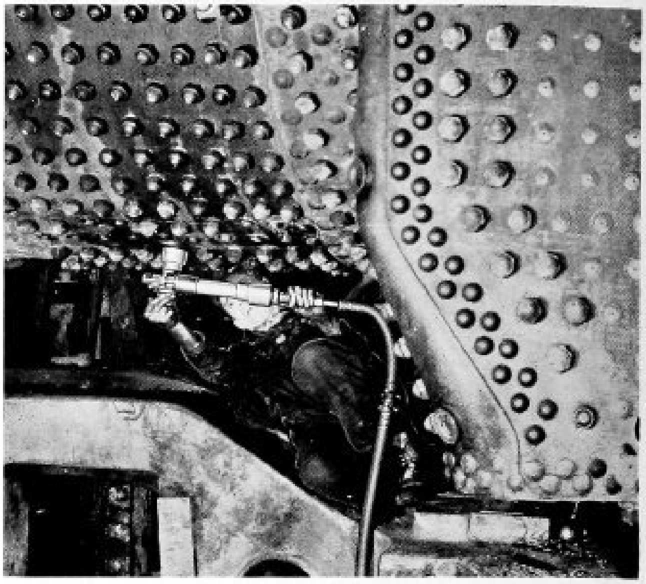
Pneumatic Wrench Incorporates New Principle

A pneumatic tool, combining the actions of a hammer and a wrench, introducing a principle of operation that is distinctly new, has been introduced by the Independent Pneumatic Tool Company, Chicago, makers of Thor portable power tools.

This new tool, the Thor No. 603 Hamerench, applies and removes all types of nuts in locomotive work, structural steel work, shipyards, refineries, automobile plants, etc. Being of the right angle type and operating horizontally to the application, this machine permits operation in places absolutely inaccessible to the straight machine, which needs a space considerably greater than its overall length in which to apply or remove nuts.

Particularly in the locomotive field is the tool operating with unusual satisfaction. Here it has applied and removed nuts in applications previously accessible only by the hand method, which of course, is a tremendously slower process. Nuts and flexible staybolt caps are applied and removed by timed direct rapid hammer blows, delivered at right angles to the nut, an entirely new principle of operation.

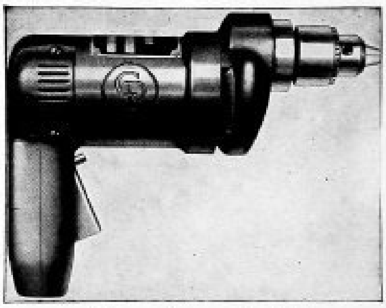
By changing the socket from one end of the spindle to the other end, the tool is made reversible. Force of torque is not employed, consequently there is no danger of shock to the operator. The tool is constructed of alloy steel throughout.



Hamerench being employed on firebox work

Midget Electric Drill Developed

The Chicago Pneumatic Tool Company, New York, has recently announced an addition to its list of electric drills. The newcomer is outstanding due to its remarkably small size, as it is only $7\frac{1}{16}$ inches long, weighs 2 pounds 10 ounces, and is specially designed for $\frac{3}{16}$-inch wood and metal drilling. The new tool is of the usual pistol-grip design and incorporates a rugged construction with economical operation. The motor base and grip can be interchanged with a gear case assembly for a screw driver and nut runner.



Chicago Pneumatic drill

Acetylene Congress Held in London

The centenary of the introduction of acetylene gas, and the fiftieth anniversary of the first use of industrial oxygen, has just been celebrated in the United Kingdom by the Twelfth International Congress of Acetylene, Oxy-Acetylene Welding and Allied Industries, which held its technical sessions in London. Over six hundred delegates, representative of fifteen countries, were in attendance. King Edward, who accorded his patronage to the congress when he was Prince of Wales, sent a telegram wishing the congress success.

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

VOLUME XXXVI NUMBER 7

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BUSINESS MANAGER: Warner Lumbard.

Contents

Lord Alness, who welcomed the guests at the opening of the congress at the Guildhall, said that the congress had four important features. "It is the first time," declared Lord Alness, "that the Congress has been honored by Royal patronage; it is the first acetylene congress to be held in London for 28 years; it coincides with the centenary of the discovery of acetylene gas; and it marks the fiftieth anniversary of the first commercial production of oxygen."

Subsequently Lord Alness distributed the prizes awarded for papers submitted to the congress, the gold medal of the congress going to M. R. Meslier (France) and a special gold medal for the best paper submitted in English by persons of British nationality going to C. G. Mambridge and R. E. Dore, jointly. Among the papers read at the technical sessions was one offering an historical survey of industrial oxygen production, others dealing with such subjects as radiography as applied to welding, railroad uses of oxy-acetylene welding and cutting, the weldability of steels, and oxy-acetylene welding in the chemical industry.

FitzSimmons made Vice-President of Flannery

E. S. FitzSimmons, manager of sales of the Flannery Bolt Company, Bridgeville, Pa., has been appointed vice-president; W. C. Masters has been appointed sales engineer; Leo Finegan, eastern sales manager, and W. M. Wilson, western sales manager.

Oxy-Acetylene Cutting Featured at Foundry Show

Oxy-acetylene machine and hand cutting methods featured the display of The Linde Air Products Company and the uses of chromium in iron and steel castings were emphasized by the Electro Metallurgical Company at the Foundry and Allied Industries Exposition held in Detroit from May 4 to 9. These two units represented the Union Carbide and Carbon Corporation.

Chicago Pneumatic Tool Company Announcements

On and after June 1, 1936, a sales and service branch of the Chicago Pneumatic Tool Company will be maintained at 2415 Commerce Street, Dallas, Tex., under the management of D. G. Reeder, district manager. Effective upon the same date, the Pittsburgh office of the company will be located at 810 Chamber of Commerce Building, Pittsburgh, according to a recent announcement by H. H. Sherman, publicity manager.

Manager for Babcock and Wilcox Tube Sales

Edward A. Livingstone has recently been appointed manager of alloy tube sales for The Babcock & Wilcox Tube Company, Beaver Falls, Pa. Prior to this appointment, Mr. Livingstone was engaged in the development and introduction of special Babcock & Wilcox high-temperature, corrosion-resistant alloys to the oil industry in the United States.

Before becoming connected with The Babcock & Wilcox Tube Company, in January, 1933, Mr. Livingstone was successively district sales manager for the A. O. Smith Corporation in Los Angeles, Tulsa, and New York City.

Engineering Chief for American Locomotive

J. G. Blunt, mechanical engineer of the American Locomotive Company, has been appointed chief mechanical engineer, with headquarters at Schenectady, N. Y. Mr. Blunt is a graduate of the University of Michigan, where he obtained his Bachelor of Science degree in 1894. In 1897, after a few years' experience as a machinist and draftsman with several manufacturing concerns, Mr. Blunt became a draftsman in the employ of the Brooks Locomotive Company at Dunkirk, N. Y. In 1899 he was promoted to the position of foreman and later became chief draftsman. In 1906, when the general drawing room of the American Locomotive Company was formed by moving all the subsidiary plant engineering forces to Schenectady, Mr. Blunt, under the title of engineer of the drafting department, was assigned the duties of organizing these combined forces at Schenectady. Following this he was appointed superintendent of the general drawing room, and in 1916 became mechanical engineer.

Questions and Answers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Hot Water Storage Tanks

Q.—How is the size of a hot water storage tank determined? J.B.J.

A.—The amount of storage provided in hot water storage tanks is, as a rule, a matter of choice but usually is made ample enough to carry over the peak shortage which is most likely to occur. It is based on the assumption that only 75 percent of the storage capacity will be available, as it has been found that if more than this amount is withdrawn from storage, the tank is so cooled down as to make the balance useless. The general rule may be cited that the less the heating capacity the greater must be the storage and the greater the storage the less may be the heating capacity down to a point where the heating capacity will fail to be sufficient to heat up the tank storage during periods of small load.

Example:

A heater to supply 400 persons will have an average daily use of about

$$400 \times 40 = 16{,}000 \text{ gallons}$$

and this is an average of

$$\frac{16{,}000}{24} \text{ or } 666 \text{ gallons per hour}$$

but the peak hour will require

$$\tfrac{1}{10} \text{ of } 16{,}000 \text{ or } 1600 \text{ gallons per hour}$$

and the shortage during the peak hour if the heating capacity is made to suit the average hourly use of 666 gallons will be:

$$1600 - 666 \text{ or } 934 \text{ gallons,}$$

so that the storage capacity, based on 75 percent being available from this capacity without cooling the tank excessively, will be:

$$\frac{934}{0.75} \text{ or } 1258 \text{ gallons.}$$

In case it is desired to reduce the size of the storage tank and to use a greater heating capacity, it is only necessary to increase the heating capacity to say 1000 gallons per hour, which then gives:

$$1600 - 1000 \text{ or } 600 \text{ gallons,}$$

as the storage during the peak hour, and the necessary storage will be

$$\frac{600}{0.75} = 800 \text{ gallons;}$$

or, the heating capacity can be increased to 1200 gallons, leaving a shortage of

$$1600 - 1200 \text{ or } 400 \text{ gallons,}$$

and the storage required will be

$$\frac{400}{0.75} \text{ or } 533 \text{ gallons.}$$

Good design requires that the heating capacity be made as small as possible without introducing an undesirable amount of storage as the heating capacity directly determines the load on the source of heat.

As indicated in the example, the heating load is proportionate to the heating capacity and the boiler capacity must be increased for higher heating capacities and may be reduced for smaller heating capacities with greater storage. It may be assumed that a boiler capacity of 3.33 square feet of equivalent steam heating surface (radiation) must be provided for every gallon of water heated 100 degrees or from 50 degrees F. to 150 degrees F., which is the temperature most commonly assumed and required. On this basis it will be seen that the various conditions cited in the example will require additional boiler capacity, as follows:

Heating Capacity gallons per hour	Additional Boiler Capacity Square feet radiation
666	2207
1000	3330
1200	3996

From this it is apparent that it is less costly to provide ample storage space and to reduce boiler capacity than to diminish the storage capacity and supply a greater increased boiler capacity to compensate.

Methods of Welding Boiler Tubes

Q.—We wish to know which is the best method in welding boiler tubes in the tube sheet? One method is expanding tubes, then bead same as if you were not welding, then weld bead to tube sheet. The other method is to expand tubes in sheet the proper length to bead, then weld without beading. H.M.

A.—Of the two methods of welding boiler tubes in the tube sheet outlined in the question, the method of expanding the tube and then beading over as if you were not welding and then welding bead to tube sheet, would be most preferable due to the fact that the bead supports the weld. However both methods are used, the boiler code or law under which the particular boiler is built governing each particular case.

Typical rules are as follows:

A fire-tube boiler shall have the ends of the tubes firmly rolled and beaded, or rolled, beaded and welded around the edge of the bead. Where the tubes do not exceed 1½ inches in diameter, the tube sheet may be chamfered or recessed to a depth at least equal to the thickness of the tubes and the tubes rolled into place and welded. In no case shall the tube end extend more than 3/8 inch beyond the tube sheet. In the case of tubes not exceeding 1½ inches diameter, they may be expanded by the prosser method in place of rolling.

The ends of all tubes shall be expanded and flared not less than 1/8 inch over the diameter of the tube hole on all watertube boilers and superheaters, or they may be flared not less than 1/8 inch, rolled and beaded, or flared, rolled and welded. Tubes may be seal welded into fittings or headers, for both boilers and superheaters, after they have been expanded and flared, provided the materials in the fittings or headers do not contain carbon in excess of 0.30 percent.

The ends of all tubes, suspension tubes and nipples of watertube boilers and superheaters shall project through the tube sheets or headers not less than ¼ inch nor more than ½ inch before flaring. Where tubes enter at an angle, the maximum limit of ½ inch shall apply only at the point of least projection.

For locomotive boilers, the ends of the tubes shall be substantially rolled and beaded, or rolled and welded, at the firebox or combustion chamber end, and rolled at the smokebox end with 10 percent of the tubes to be beaded at the smokebox end.

Trade Publications

Midget Hand Drill.—A booklet, shaped to the exact dimensions of a new lightweight electric drill, and giving full details of this tool, has been prepared by the Chicago Pneumatic Tool Company, New York.

General Steel Data Book.—Joseph T. Ryerson & Son, Inc., manufacturer of steel for all purposes, has prepared a general data book on the properties, methods of heat treating, tempering and annealing, physical characteristics and dimensions of all grades and types of steel.

Stainless and Heat Resisting Steels.—The Peter A. Frasse Company, Inc., New York, steel distributor, has published a 42-page booklet on Fabrication and Treatment of USS Stainless and Heat-Resisting Steels. The booklet contains a summary of the latest information on the fabrication and treatment of stainless steels, carefully indexed, and is designed not only for general information but as a practical help for the engineer and shop foreman.

Metal-Clad Switchgear.—The General Electric has prepared a catalogue on the subject of metal-clad switchgear, which is a highly developed piece of equipment combining circuit breakers, disconnecting devices, buses, instruments, transformers, interlocks, etc., all enclosed in a single unit. Description is given of the economy effected by the use of this equipment along with photographs and drawings showing construction and dimensions of the various types manufactured by the General Electric Company, Schenectady, N. Y.

Non-Return Valves.—Selection of the correct size of non-return valves, details of design, choice of materials and the functions of the impact type of hand-wheel are among the subjects discussed in a new catalogue recently brought out by the Edward Valve and Manufacturing Company, Inc., East Chicago, Ind. Dimensions and description of a complete line of valves for all standard pressures and made of a variety of materials are included in this publication. A brief section is devoted to forged stop-check valves, with both screwed and flanged ends.

Thermocouple Pyrometers.—A new 52-page catalogue has just been issued by Leeds & Northrup Company, Philadelphia, manufacturer of measuring instruments, telemeters, automatic controls and heating furnaces. It explains the potentiometer method of measurement and the operation and mechanism through which this balanced measuring system is made available to industries. Set forth for ready comparison is the complete line of Leeds & Northrup indicators and recorders, besides a quantity of data for all interested in industrial pyrometers.

Portable Cable.—A new edition of the bulletin "Portable Cable" has been recently issued by the General Electric Company, Schenectady, N. Y. This publication gives complete data and listings of all types of tellurium all-rubber, Glyptal compound and braided types of portable cable for mining, welding and transit equipment, electric shovels and dredges and similar apparatus. The new features of this publication are the new loom-sheath and Glyptal compound types of shielded cable for service on dredges and shovels and new cable connectors, terminals and couplers.

Steam Engines.—One of the most complete bulletins on the subject of steam engines has been recently published by the Troy Engine and Machine Company, manufacturer of steam engines, generating sets and generators, Troy, Pa. The publication is profusely illustrated with photographs of various installations of Troy engines in all forms of industrial manufacturing plants, hotel, hospital and building power plants and of marine auxiliaries. In addition, discussion is included of the advantages of using steam for many various purposes, together with tables of brake horsepower, water rates, dimensions and operating characteristics of the long line of Troy engines.

Refractories Handbook.—The Standard Fuel Engineering Company, Detroit, has recently published the "Standard Hand Book of Refractories," a 48-page manual of information for engineers, plant superintendents and others interested in heat control. It contains information about refractory cements, materials and problems, useful tabular material of interest to those who use refractories, besides numerous illustrations of typical installations of a wide range of refractories. It also shows various methods of applying high-temperature cements and tables of weights and dimensions of firebrick, etc. The handbook may be obtained without charge by application to the company.

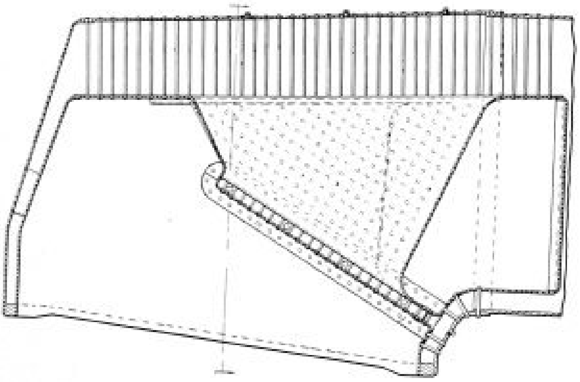
Lathe Practice.—Two new booklets entitled "How to Cut Screw Threads in the Lathe" and "How to Grind Lathe Tool Cutter Bits" have recently been prepared by the South Bend Lathe Works, South Bend, Ind. The material in the booklets is presented in such a way that it is easily understood and covers both subjects very thoroughly. A step by step description of cutting threads in the lathe is given, together with sets of tables of standard screw thread pitches, tap drill sizes, definitions of various terms relating to screw threads, etc. All methods of grinding the various types of lathe tools and recommendations for the proper use of each kind is also presented in the lathe tool booklet.

Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,994,606. LOCOMOTIVE BOILER. JOHN J. DALY, VIRGINVILLE, PA.

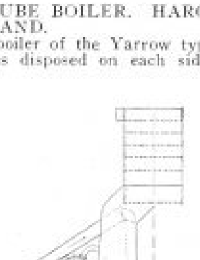
Claim.—A boiler of the character described comprising an inner fire-box-enclosing shell, an outer shell, said shells being so constructed and arranged as to provide an intervening water space and a water throat between them, said inner shell having relatively spaced elongated openings in the crown portion thereof, an opening in the throat and an elongated opening in each of the side walls thereof, the last mentioned



openings leading upwardly and rearwardly from said throat, an inclined shallow chamber having open ends secured within said side openings and an open lower side portion in communication with said throat opening, fire tubes in said lower side portion, and legs secured within the openings in the crown of said inner shell and also secured to said chamber in a manner to communicate with the interior thereof, said legs being relatively spaced and each extending approximately the full length of said chamber. A boiler of the character described comprising an inner fire-box-enclosing shell, an outer shell, said shells being so constructed and arranged as to provide an intervening water-space and a water throat between them, said inner shell having relatively spaced elongated openings in the crown portion thereof, an elongated opening in the throat and an elongated opening in each of the side walls thereof, the last mentioned openings leading upwardly and rearwardly from said throat opening and terminating a substantial distance below said crown portion, an inclined shallow chamber consisting of flanged open ends engaging and secured to the edges of said side openings, and an open lower side portion provided with flanges engaging and secured to the edges of the opening in said throat, said chamber having elongated openings in its top wall, the forward ends of said openings terminating rearwardly of the forward end of said chamber, water legs having flanges at their upper ends engaging and secured to the openings in said crown portion, and having flanges at their lower ends engaging and secured to the edges of said top wall openings, and fire tubes passing through said chamber between the boiler throat and the forward ends of said legs. *Four claims.*

1,888,153. WATER TUBE BOILER. HAROLD EDGAR YARROW, OF GLASGOW, SCOTLAND.

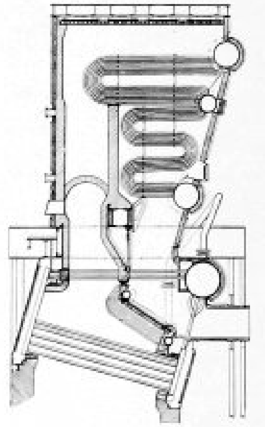
Claim.—A water tube boiler of the Yarrow type, comprising an elevated steam drum, water drums disposed on each side of a combustion space,



banks of steam generating tubes connecting said water drums to said steam drum and forming therebetween unbaffled passages for furnace gases from the combustion space on each side of said space, a superheater situated beyond one of said banks of steam generating tubes in the direction of flow of the furnace gases, a furnace wall situated below the water drum with which the last-named bank of steam generating tubes is connected, a range of burners fitted in the said wall and directed away from said bank of tubes towards the opposite side of the combustion space, and separate damper-controlled uptakes located on opposite sides of the steam drum. Two claims.

1,883,303. STEAM BOILER WITH SUPERHEATER AND REHEATER. HOWARD J. KERR, OF WESTFIELD, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

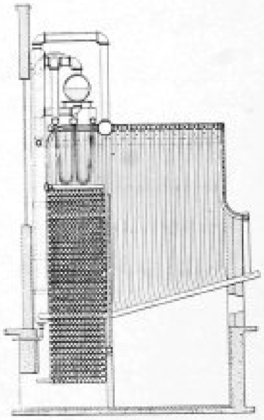
Claim.—In a boiler, a bank of inclined steam generating tubes, a super-



heater located along one side of the gas path beyond said bank of tubes having its tubes inclined at a greater angle than the tubes of said bank, the superheater tubes adjacent the gas path being spaced apart farther than those remote from said gas path. *Four claims.*

1,887,854. DRUMLESS BOILER. GEORGE LASKER, OF CHICAGO, ILLINOIS.

Claim.—A boiler comprising a plurality of inter-connected tubes and headers, a static head drum positioned at an elevation above the boiler, a standpipe projecting above said boiler and drum, a conduit connecting the



boiler and standpipe, said conduit being at a lower elevation than said drum, a conduit connecting the upper portion of said boiler with the upper end of said standpipe, a conduit connecting the upper end of said standpipe with the upper portion of said drum, and a conduit connecting the lower portion of said drum with said boiler. *Four claims.*

Boiler Maker and Plate Fabricator

Fabrication of Boilers and Heavy Plate Products

Elsewhere in this issue the statistical record of improvement in production in the boiler manufacturing and plate fabricating industries is given. The recovery in these industries, which got under way in 1935, is now going forward at an accelerated rate. The level of production now exceeds that of 1932 and with a continuation of the favorable trend will approach that of 1931.

Considering the building up process as one of the past three years, however, there is a great deal of encouragement from the study of relative production during these years. Without repeating the statistics referred to, the first six months of 1936 shows an increase in production of 47.5 percent in number and 74 percent in area of heating surface of boilers over that of 1935. Compared with 1934, the figures are 136.5 percent in number and 142 percent in heating surface. A higher peak of production was reached in June than in any month for the past four years.

In the heavy plate fabricating industry the same condition holds true for monthly production, and for the six months' record only a small percentage less tonnage was produced than in each of the entire years of 1935 and 1934. A total of 229,482 tons of various products was fabricated during this period exceeding by nearly 131 percent the production for the same period in 1935 and by over 65 percent that of 1934.

The record speaks for itself. There is every indication that further improvement will be realized during the remaining months of the year.

Master Boiler Makers' Meeting

In another few weeks the master boiler makers of the country will be gathering at the Hotel Sherman, Chicago, for the second of their annual business meetings which have come to replace the conventions of pre-depression years. The favorable reactions on the part of railroad officials generally, which followed the successful meeting of last year, will bear fruit at the forthcoming meeting on September 16 and 17 in a far greater attendance of key men from the boiler department.

When the association fixed upon the words, business meeting, to designate the gatherings of this group in the future, it was done with the determination to produce as much of value to the railroads as any gathering of business men could accomplish. There can be no question but that the results have justified the struggle of years through which the secretary and a few of the officers did their utmost to hold the membership together. The meeting in 1935 paved the way for a complete rehabilitation of the association and renewed the zeal of its members in advancing its prestige in the future.

One means by which it is hoped to accomplish this objective is a revision of the present constitution and by-laws, which will make possible a more modern setup for the executive officers who head the association. No action taken by the membership can be more important than the passage of rules which will insure at all times in the future the election of the best and most progressive individuals among the master boiler makers of the country to positions of authority in the association. Progress is only made when such men are in control.

In former years, there may have been times when elections were based on considerations of policy and the influence of certain groups rather than upon the fundamental requirement of the association's best interests. The present move should largely overcome any possibility of future injections of association politics into elections.

The program this year is excellent and should develop a great deal of worthwhile discussion, all of which will react to the benefit of the railroads, who indicate their interest in the association by sending representatives from their boiler departments. In this connection, there can be no question but that railway mechanical officers of every railroad in the country should make certain there is at least one member of the boiler department, supervisory or inspection staff in attendance. The slight expense and inconvenience to shop operation involved is more than made up by an increased understanding and a broader viewpoint of the problems which constantly crop up in connection with boiler work. This fact is more evident than ever in the fast-changing picture of motive power development.

The fact has often been emphasized that these meetings constitute one of the best means for broadening the vision of the boiler department supervisor. Particularly is this true of the younger members of the fraternity, who in ever increasing numbers are coming into positions of importance to fill the gaps created by the retirement of old timers and to meet the pressure of production. No more broadening influence is possible than the contacts gained at such gatherings of men intent on building up the craft to which they devote their lives.

As in 1935, no supply exhibits of materials and equipment are planned this year. The October issue of Boiler Maker and Plate Fabricator, as in former years, will be devoted to a complete account of the proceedings of the Master Boiler Makers' Association meeting. Many companies will take advantage of this opportunity of displaying their products in connection with this report as a means of conveying their messages pertaining to boiler work to members of the association and to higher railroad officials. It is unfortunate that exhibits have been curtailed, but it may be in another year the supply group will see fit to reinstate this outstanding feature of meetings of mechanical and supervisory staffs. Until then the proceedings issue of publication devoted to the various branches of the railroad industry offer an excellent substitute for purposes of exhibit display and supply information.

Using the impact wrench on staybolt caps

During the past six years the Reading Company has concentrated the major part of its locomotive repair work at its main shop at Reading, Pa. This shop was built in 1905 and consists principally of a main machine and erecting shop 200 feet by 750 feet having 68 erecting pits of the transverse arrangement, 34 on each side of the building, with a large machine bay the full length of the building between the two erecting bays. At the north end of this building and continuous with it is a 192-foot by 404-foot extension containing the locomotive wheel and driving box departments. In this extension are also longitudinal repair tracks where Mallet type locomotives and rail motor cars are repaired. Locomotives enter and leave the main shop by a track served by a turntable; the machine shop extension is served by tracks entering at the north end of the building. Adjacent to the machine and erecting shop are the blacksmith shop, boiler shop, foundry and carpenter shop.

Modern locomotive repair methods at

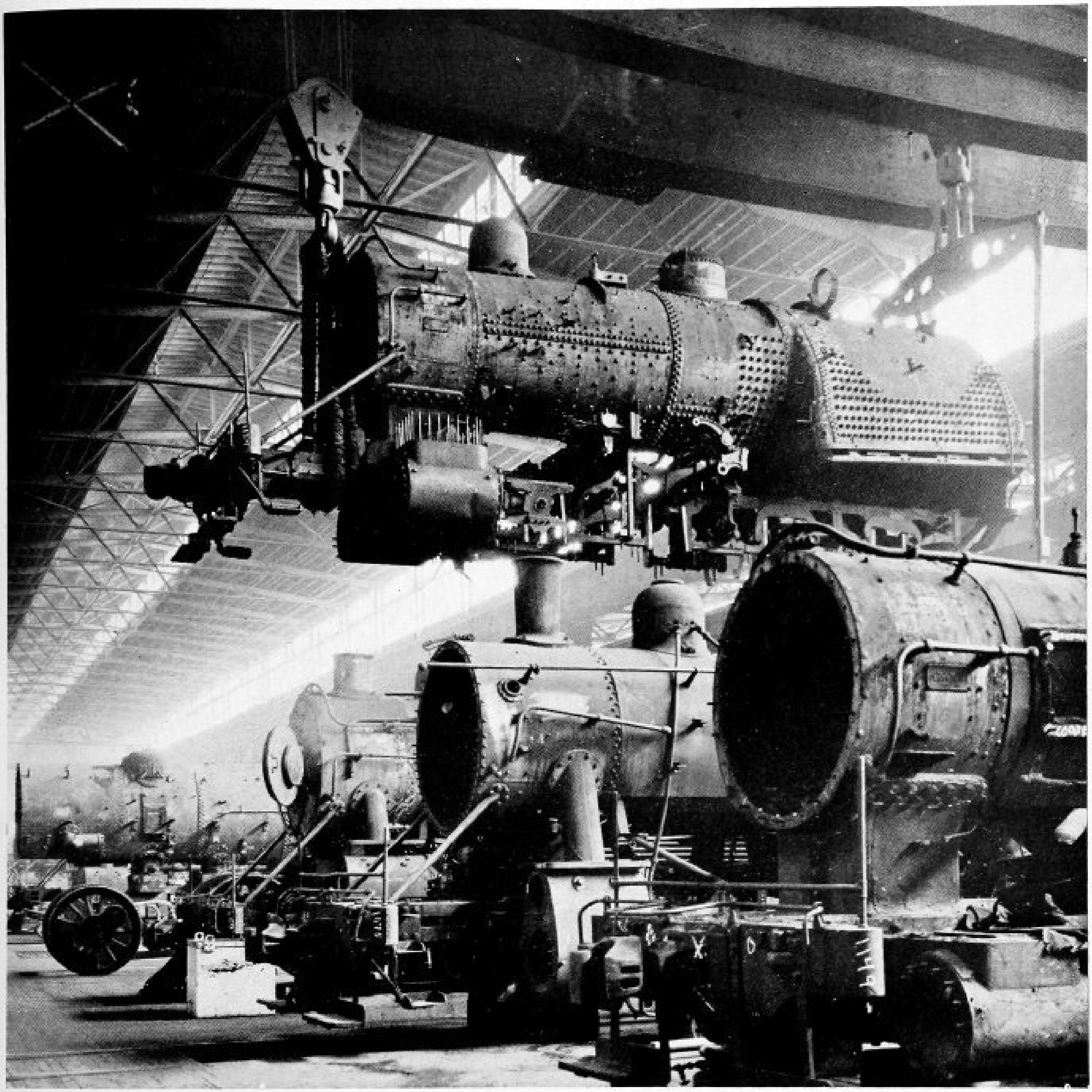
READING SHOPS

The Reading Company owns 775 steam locomotives of which 708 are of the following types:

Service	Type	No. Owned
Switching	0– 6–0	72
	0– 8–0	42
Passenger	4– 4–0	24
	4– 6–0	68
	4– 4–2	22
	4– 6–2	40
Freight	2– 8–0	353
	2– 8–2	57
	2–10–2	10
	2–8– 8–2	20

Of these 708 locomotives, comprising over 91 percent of the ownership, 306 are less than 20 years old. It will be noted that almost half of the Reading motive power, 45.5 percent, consists of Consolidation type locomotives, 150 of which are less than 20 years old. During the depression the Reading Company encountered problems common to most American railroads. Between 1930 and 1934 operating revenue dropped 45 percent, with a reduction of over 30 percent in revenue ton-miles. Transportation service locomotive miles dropped 38 percent and, as a result, expenditures for steam locomotive repairs were reduced 47 percent.

Faced with the problem of maintaining efficient transportation service under such conditions the management set out to adapt its operations to changing conditions. Those in charge of the locomotive repair work made detailed studies of the repair problem, particularly as related to classified locomotive repairs, with the result that in 1932 the Reading took a radical step and changed the shop operation over from the former conventional system of repairing locomotives at fixed shop locations and introduced a progressive or "spot" system of repairs, in which certain sections of the shop were equipped for specialized repair work and the locomotives moved from section to section during the progress of their passage through the shop. The results so far obtained since the introduction of this progressive system are of particu-

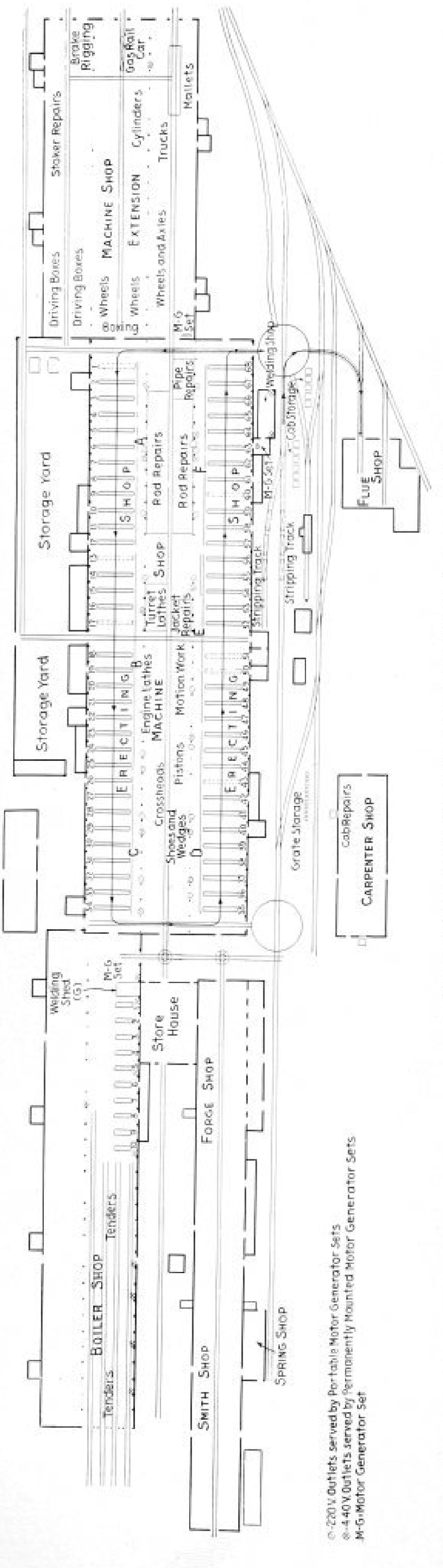


Spotting locomotives by means of the overhead crane at the Reading shop

lar interest to railroad men because of the fact that the progressive system of locomotive repairs has not been generally believed to be well adapted to the transverse type of shop. It must be borne in mind that, under the necessarily curtailed operations of the past four years, it is not possible to determine conclusively the potentialities of any type of railroad shop repair system, but the results so far obtained at Reading, with the shop operating at not much more than 35 to 40 percent of its capacity, indicate that the economies so far effected have justified the step that has been taken.

Once the progressive system had been established on a working basis it became evident to those responsible for shop operations that it would not be possible to effect the desired savings unless many of the older units of machine tool equipment were replaced. Consequently another series of studies was made which, when completed, pointed definitely to the fact that a modernization program as regards shop facilities would make it possible to effect substantial economies in locomotive repair work. These studies resulted in the replacement of 49 old machine tools averaging approximately 35 years in age by 32 modern machines at an expenditure of approximately a quarter of a million dollars.

The progressive system as applied to the Reading Shop is operative only in the main erecting shop, and does not apply to the work on Mallet type engines in the machine shop extension at the north end of the shop. The erecting department was originally divided into four sections, the same work being performed in each section, making it necessary for workmen to go to each of the four sections of the shop in order to perform similar work. Under the progressive system this has been



Layout of the Reading locomotive repair shop showing the location of the various departments and the route taken by locomotives undergoing repair

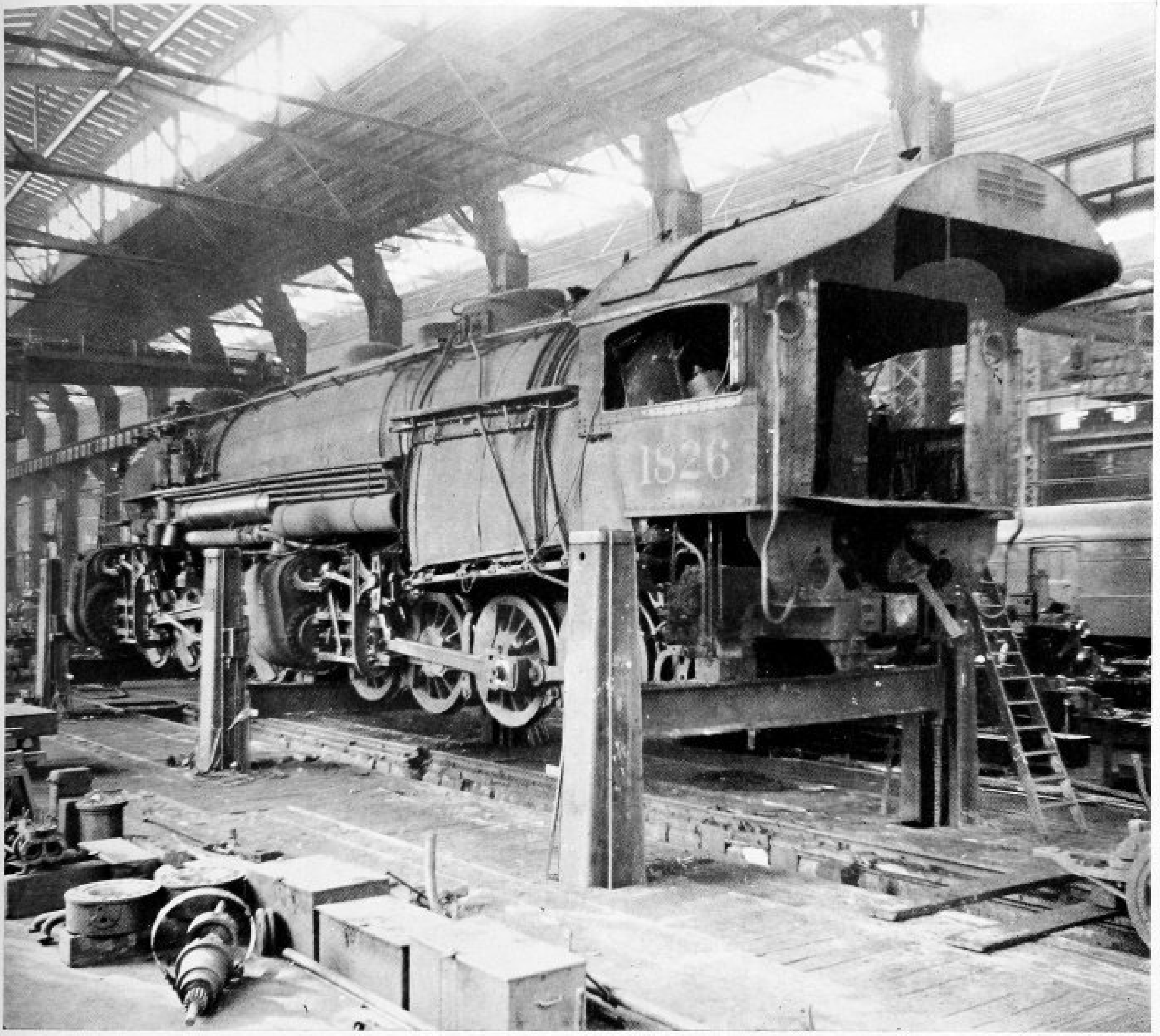
changed, so that each class of work is performed in one section only. The definite operations are grouped in a sequence from beginning to end, each group being performed at designated locations which are known as "sections," there being six of these in all, three in the east bay of the shop and three in the west bay.

The sections are designated by letters, and each section is distinguished by a different color which appears on the section marking sign located on the shop wall. At each pit location there is also a marker sign, which shows the number of the locomotive which is on that pit at any given time. These marker signs simplify the problem of locating any particular locomotive. In general the principal difference between the progressive system and the former conventional system, is that the locomotives move to the workmen rather than the workmen to the locomotives. Individual sections of this shop have been fitted to do specialized work with convenient racks for the storage of locomotive parts. Material ordered for application to locomotives is delivered to these various sections in accordance with the schedule calling for its application. The general operations involved in locomotive repair work which are performed at each section are as follows:

Color designation	Letter	Operation
Red	A	Stripping, unwheeling, cleaning.
White	B	Light boiler work, heavy boiler work, flues applied, boring cylinders, fitting braces.
Blue	C	Light boiler work, heavy boiler work, flues applied, boring cylinders, fitting braces.
Green	D	Frame work and cylinders, dry pipe, steam pipe, throttle and throttle rigging, waist sheets, pressure fittings, testing boiler.
Brown	E	Jacket, cab, footboards, etc., grates, ashpans, smokebox, spring rigging, valve rigging, stokers, injectors, air pump, guides, pilots, couplers, etc.
Yellow	F	Wheeling, pipe work, rods applied, shoes and wedges, pedestal braces, brake rigging, valve setting, finishing, inspecting.

Inasmuch as the tracks in this shop are transverse in arrangement it is necessary to lift a locomotive by crane from one section to another. After the work in the three sections of the west bay has been completed the locomotives are moved across the south end of the shop to the east bay by means of a tractor. Each of the bays in the machine and erecting shop is adequately served by traveling cranes. Locomotives coming to the shop for repairs are moved into the shop yard and placed in the stripping location outside of the east side of the shop. This stripping location forms part of Section A. At this point, cabs, jackets, brake rigging, smokebox fronts, reservoirs, steam pipes, stokers and grates are removed. When flues require renewal they are removed at this section and an internal inspection is made of the boiler and firebox. The wheels and rods are left on the locomotives to be removed later, after they have been taken into the shop. The stripping track is served by a steam locomotive crane.

After the preliminary stripping operation has been completed, the locomotives are moved to a turntable at the northeast corner of the shop and delivered over a track extending across the north end of the erecting shop to Section A where the final unwheeling and cleaning is performed. After the parts which have been removed from the locomotives have been cleaned, (including piping, pedestal braces, clamps, steam pipes, throttle rigging, etc.), they are stored in the yard outside of the shop. Under the former system of shop operation, this material was stored in pits adjacent to the repair tracks. This caused considerable congestion in the shop and constituted somewhat of a hazard to the workmen. Under the present method this material is stored at fixed locations where it is conveniently accessible, and is delivered back to the shop at the finishing location when required.



Mallet type locomotives are repaired at a special location equipped with a Whiting hoist

After the work in Section A has been completed the locomotive is then lifted by the overhead crane to Section B or C. Whether a locomotive, in its progress through the shop, enters section B or C depends upon the extent of the boiler work to be performed; heavy boiler repair jobs, such as heavy firebox work, are performed in Section C exclusively. A locomotive may or may not spend time in all six sections of the shop depending upon the nature and extent of the work to be done. On particularly light repair jobs it is quite possible that certain sections of the shop may be skipped by a locomotive in its progress through the shop.

After the work in Section B or C has been completed the locomotive is removed by tractor across the shop to section D, where the heavy machine work such as frame work and cylinders is done. In this section such work as dry pipe, steam pipe, throttle and throttle-rigging repairs is taken care of, and the necessary tests on the boilers are made. After work in Section D is completed, the locomotive is lifted by crane to Section E which is the first of the two final assembly positions. Here the jacket, cab and running boards are applied. The smokebox work is done, grates and ash pans are applied, spring rigging, valve gears, injectors, air pumps, guides, pilots, couplers, etc., are all put on.

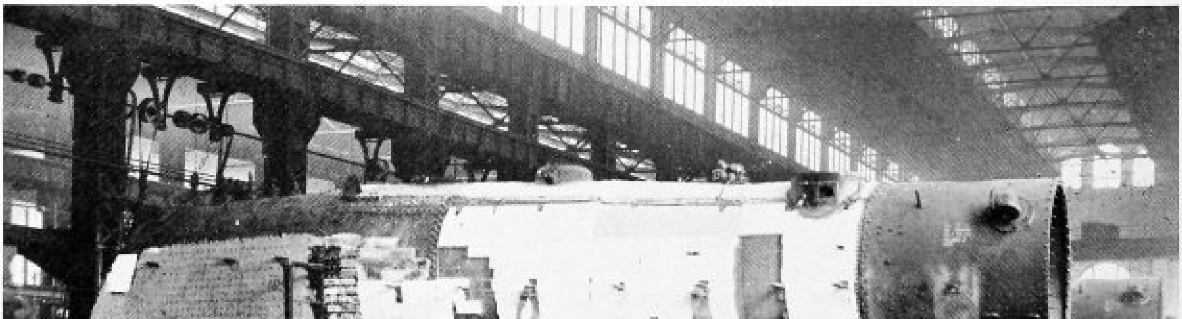
From Section E the locomotive is lifted to the finishing section, which is designated as F. One of the pits in this section is especially equipped for wheeling engines. Here the wheels and rods are assembled, driving boxes and shoes and wedges are put up and when these parts are ready the locomotive is lifted over and wheeled. This work is done on a second trick so as not to interfere with the routine work of the first-trick workmen. After the engine is wheeled, the brake rigging is applied, the valves are set and the engine is ready for its final finishing and inspection. A certain part of the painting is done in Section F and then the locomotive is moved to the engine house, which lies immediately north of the shop, where the final painting is done and the engine fired up. The operations involved in Section F include the final work in the engine house. The finish painting of a locomotive is not done until after it has made its break-in run and all repairs and adjustments necessary as a result of the break-in have been made.

Locomotives are stripped in Section A outside the shop

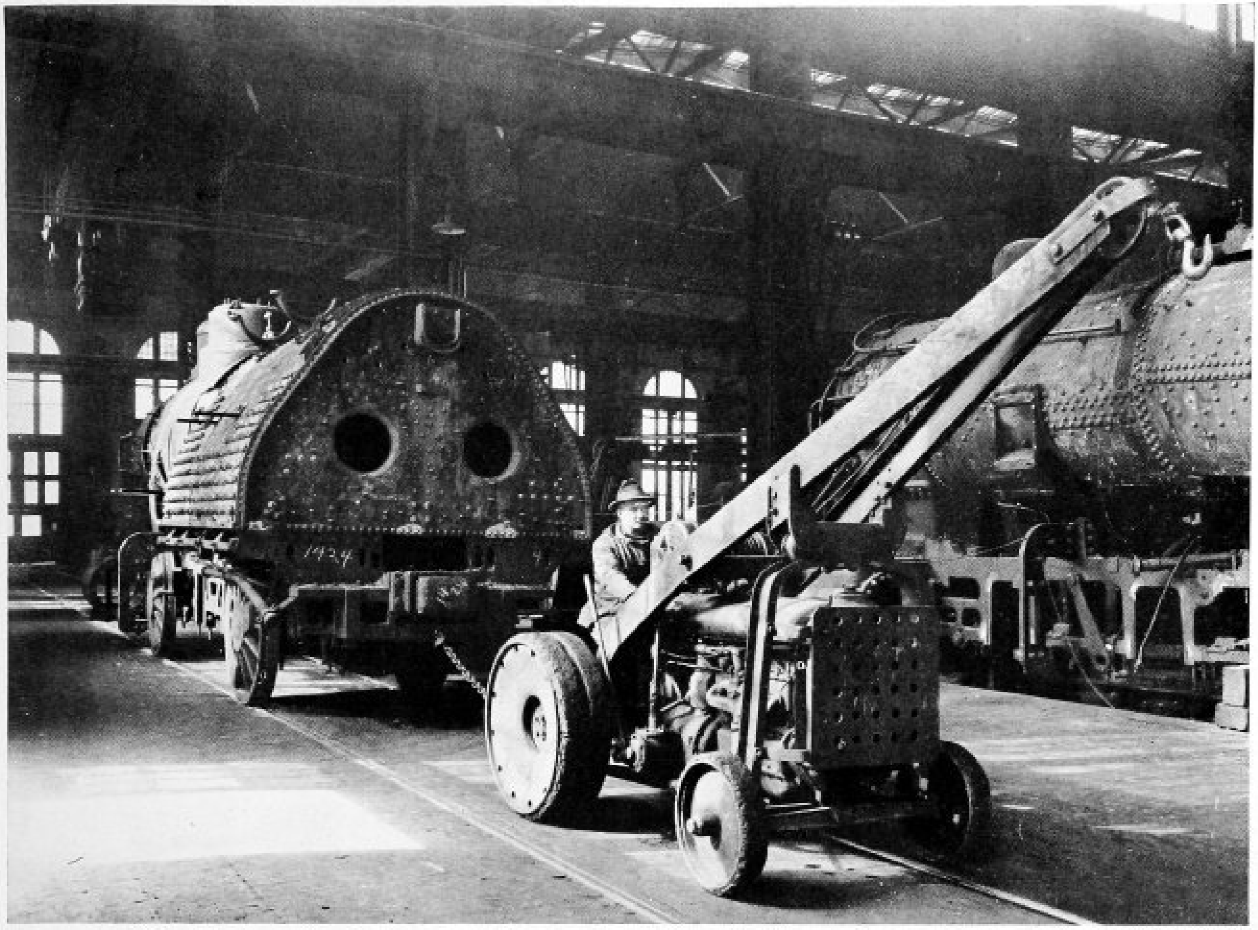
All of the operations in the locomotive department are controlled by a master schedule system. When a locomotive is taken into the shop for repairs, it is first thoroughly inspected and the class of repairs determined. Depending upon the class and nature of the repairs, a given number of working hours is allowed to complete the work on the locomotive. Each department in the shop is allowed a specific time for the completion of its part of the work and the shop supervisor follows the progress of all of the departmental work, in order that delays may be avoided. The progress reports of parts passing through repairing departments are entered on a departmental schedule form and a master schedule sheet is posted, so that it is possible to determine whether or not the work on any particular locomotive is proceeding according to the schedule, which has been previously determined.

An analysis of the number of shop days required to repair, for example, Reading type 2-8-0 or 4-6-2 locomotives shows that since the installation of the progressive system the following reductions in the scheduled time in the shop have been effected:

On Class 2 repairs	29.0 percent
On Class 3 repairs	27.5 percent
On Class 4 repairs	26.0 percent
On Class 5 repairs	24.0 percent
On recondition repairs	30.0 percent
Average reduction	27.0 percent



A view in the assembly section of the erecting shop



After boiler work is completed in Section C the engines are moved across the shop by tractor

At the time of the introduction of the progressive repair system a material delivery system was established, which obviates the necessity of workmen leaving their posts for any material that may be required in the process of repair work. Locomotive parts which have been removed are distributed to the proper departments for repair by means of this delivery system and finished parts and material from the store house are delivered in a like manner. The delivery system utilizes tractors and trailers, and operates over eight designated routes—seven of which serve the locomotive departments. One route serves the general store house, oil house, electric and superheater repair shops; another route serves the engine house and wheel shop. Three routes serve the machine and erecting shops and the machine shop extension; one route serves the foundry, boiler shop and blacksmith shop, and a seventh route operates between the main shop and the engine house. The eighth route is confined entirely to the car shop.

It became evident after the introduction of the progressive repair system that substantial economies could be effected by modern machine tools. There are, in the machine shop at Reading, approximately 300 major machine-tool units. About 85 percent of these were purchased prior to or at the time the shop was built in 1905, the remaining 15 percent having been purchased at various times since then. There has not, however, until now, been any major tool replacement program, with the result that many of the machines had outlived their economic usefulness.

As a result of the studies made 49 obsolete machines, having an average age of approximately 35 years, were retired and replaced by modern tools.

Welding Procedure Control in Principle and Practice

Experience in many fields over a number of years has conclusively shown the value of procedure control as a method of enabling the management of a plant or shop to exercise complete control over welding operations. Through consideration of the six factors outlined briefly below for oxy-acetylene welding, a procedure control can be prepared to cover any specific welding or cutting operation.

Qualification tests should be given to welders before they are allowed to go to work. These tests should duplicate as nearly as possible the conditions under which the welder will have to work in the factory. General statements of past experience are not permitted to bear a great deal of weight. The operator's speed and technique in welding or cutting suitable test metal are carefully observed by the foreman or inspector. The specimen welds must pass certain specified tests for tensile strength, ductility, soundness and other factors depending upon the exact nature of the work. During the welder's employment his work should be carefully checked at intervals. Best practice indicates that this should be done as far as possible without his realizing it. This will give a continuous check on the quality of his work. It is also good practice to require each welder to place an identifying stamp on each completed weld.

Even the best welder cannot produce satisfactory work with poor material. The management should supply him with metal of proper grade, suitable for the work in hand. High grade welding rod of correct composition should also be supplied. Metal to be used for welding should be ordered to specifications covering not only chemical composition and physical properties but weldability as well.

Investigations made in connection with the development of welded joints have contributed greatly to our knowledge of correct design. A welded joint often necessitates different consideration from the design of a mechanical joint. This is another reason why managerial understanding of welding is so important. The failure of the drafting room to specify welded construction may seriously hamper the effective utilization of this process. For this reason the drafting room should be familiar with all matters pertaining to the correct design of welded joints.

Suitable welding apparatus should always be provided for the specific work on hand. Convenient tables, jigs, various supports, and clamps for lining up and spacing seams are also necessary. The location and number of tack-welds to be used must be pre-determined and carefully specified.

Many details of welding technique have to be considered that should not be left to the individual judgment of the operators, but should be determined in advance by the management. Correct preparation of the metal edges to be joined, correct sizes of blowpipe tips, correct pressures of oxygen and acetylene, and predetermined method of blowpipe handling are all important items to be considered.

Inspection and tests are necessary to check whether the other items of the welding procedure control have been followed and to see that proper welding results. The test of the completed work is an additional assurance that the welding installation will give satisfactory service. Whenever possible, hydrostatic pressure should be used for testing purposes. This is the current practice in testing pressure vessels, pipe lines, tanks and other products of this type. Where hydrostatic pressure tests are impossible an inspection routine based on visual, sound, X-ray or other methods can be developed.

Procedure control methods have been adopted today in nearly all industries using the oxy-acetylene process. With the above six factors as a guide, a detailed procedure control can be written to apply to any specific welding or cutting operation.

French Welded Locomotive Firebox

An experiment in the use of welding for the assembly of a locomotive firebox has been tried recently by the State Railways of France. The use of steel for locomotive fireboxes in France dates from the engines left behind by the American Army after the war; but they have always been riveted. Until then copper was used. The Paris-Orleans Railway, however, following American practice, has fitted steel fireboxes to most of their locomotives. These have proved satisfactory, and it is claimed that steel is less expensive for upkeep, as well as giving better results in service.

At the beginning of this year it was decided by the State Railway to build steel fireboxes for two Pacific-type locomotives, and as they were to be of an experimental nature it was arranged to rivet one and weld the other. The welding process being of a rather special character, it was found necessary to train men for the work. The method was carried out by oxy-acetylene process, two men working simultaneously, one from either side, and the welds made from the bottom up.

A number of minor changes in the design of the firebox had to be made. It was necessary to place an extra row of braces beyond the back and front welds to conform to the regulations. Further, as the usual type of firebox sides were used, it was found necessary to build up the edge at the point where the fire door comes.

Welding the two plates of the firebox represents a weld about 33 feet 6 inches long by ⅜ inch thick; the weld around the fire door being about 10 feet 10 inches long by ⅝ inch thick. The work consisted of adding a thickness of plate to the frame which had been pressed into shape.

In order to ensure perfect welds, the work was, on completion, photographed by the Philips Metalix process, the radiographs obtained being interpreted according to the code for welded boilers and reservoirs, adopted by The American Society of Mechanical Engineers, July, 1921.

The welding was carried out in the shops of the State Railways at Sotteville-Quatre Mares, near Rouen.—*The Locomotive* (British).

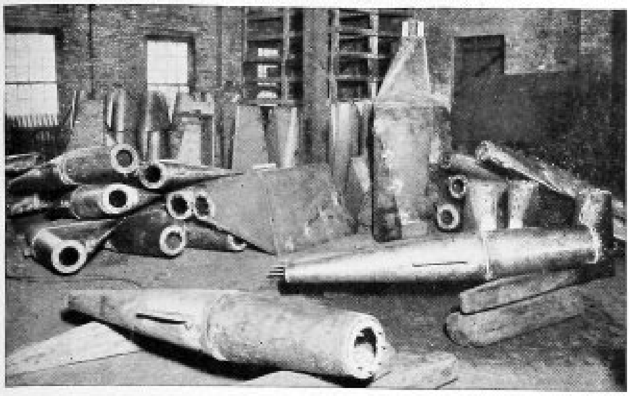
New Type Welding Generator Developed

Based on their newly developed cross-field principle a new welding generator for belted or coupled welding sets with a control system claimed to produce superior arc quality and eliminating rheostat, resistors, meter, reactor and exciter required in conventional designs, is

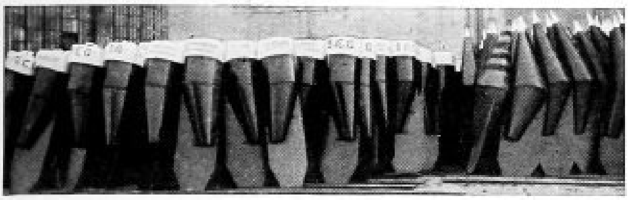
Westinghouse welding generator

announced by Westinghouse Electric & Manufacturing Company. Due to its design the welding current is unaffected by the ordinary speed variations of the driving unit.

The new 200, 300 or 400 ampere generator with a new system of control allows the operator to adjust the generator to give the welding current required before the set is started, thus eliminating the trial and error methods usually used. This control of the welding current is accomplished by purely mechanical means which vary the armature reaction fluxes of the generator. This control is continuous, without steps, and permits minute changes in current adjustment. A polarity reversing switch is provided for instantly changing the polarity of the electrode as required by different electrodes, without changing the cable connections. Elimination of the exciter makes it possible to use an exceptionally short and heavy shaft which greatly minimizes possibility of vibration.



Buoys in process of fabrication



A line up of finished buoys

Boiler shop successfully fabricates

Welded River Buoys

A centrally located company had been endeavoring to develop some new business other than its regular boiler fabrication. One definite piece of business that its representatives had been trying to obtain was the manufacture of steel river buoys for inland harbor and river use. Bids on these buoys had been let out in lots of from 100 to 300 at a time. A new request to bid on a lot of 120 buoys of 14-gage sheet metal was received, the bid specifying an all-welded buoy. They decided to find out whether it would be possible to make any money on this type of work. Their bid was based on welded construction. Although they were not familiar with this type of fabrication, they had become convinced through various contacts that such methods were profitable.

They received the contract and immediately got in touch with the manufacturer of oxygen for service and assistance. An oxy-acetylene service operator visited the shop and discovered that they were not set up for production welding of the kind required, inasmuch as their main work, boiler fabrication, was of a considerably different nature. Furthermore, there was only one welding operator at the plant and it was considered necessary to have several operators working at the same time on this work. The first step was to develop six men into competent welding operators. With the assistance of the service operator and an intensive training program, this was rapidly accomplished.

Furthermore, the service operator's experience told him that if these buoys could be bronze-welded, the fastest possible as well as the least expensive production would result. This procedure was found to be successful, and the purchaser's inspector was satisfied that bronze could be used satisfactorily.

Possible electrolytic corrosion between the two different types of metals, bronze joints on a steel base, was thoroughly investigated, but the oxygen manufacturer's engineering department, from wide experience on this particular question, was able to satisfy both the contractor and the purchaser that this would not be a consideration.

The sketches show the required amount of welding and the location of the welds. These are numbered in the sequence followed in the production set-up recommended by the service operator.

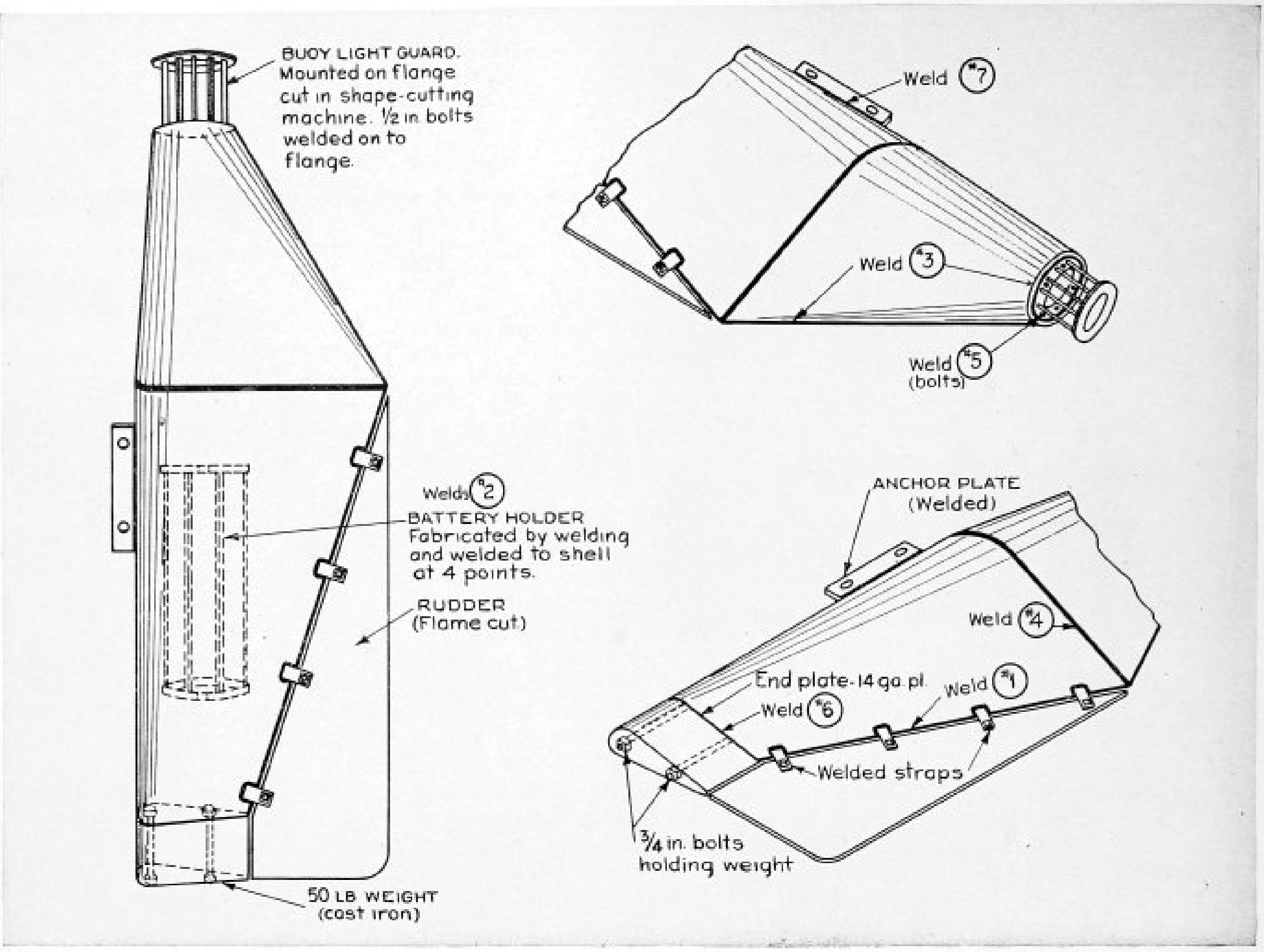
Sequence of Operations

No. 1 weld was 4 feet long. This was an edge weld. No. 2 refers to the battery holder which was entirely fabricated by bronze-welding and was subsequently welded into the shell of the buoy. Ten welds, with a total of 14 inches of welding, were required for this fabrication work. No. 3 refers to the welding, of the edge-weld type, required for the upper part of the buoy. The circumferential seam joining the upper side of the buoy with the lower, referred to as No. 4, was a butt-type joint requiring 7 feet of welding.

The flange on which the buoy light was mounted, referred to as No. 5, was made of ⅜-inch steel. The outside diameter was 10 inches, with a 6-inch diameter hole cut out of the center. Ten ½-inch bolts were then welded on to the flange in an upright position, to provide means for attaching the buoy lights. The flange itself, in turn, was welded to the top of the shell by means of a fillet-type weld. These flanges were cut from plate to finished dimensions outside and inside by an oxy-acetylene shape-cutting machine. It is interesting to note that the specifications called for a machined finish, but no further work was required to meet these specifications. Altogether, on this top assembly, there was required a total of 4¼ feet of bronze-welding, including that for the flange and the bolts.

On the bottom of the buoy there was required a 14-inch triangular-shaped plate, to provide for attaching a 50-pound cast-iron weight. This plate was welded on to the bottom of the shell, and required 3½ feet of welding. The two ¾-inch bolts, to which the counterbalance weight was attached, were also welded on in an upright position from this plate. This assembly is referred to as No. 6.

Operation No. 7 was that of attaching a ⅝-inch plate anchor by a fillet-type weld to the shell. This was used



Details of procedure control developed for welding buoys by the oxy-acetylene process of welding

to attach cables for anchoring the buoy in the river. This plate was 16 inches long and required approximately 3 feet of welding.

The final operation was the joining of the buoy rudder straps to the shell. The four straps required 2 feet of welding.

From this résumé of the production operations, it is evident that each buoy required approximately 32 feet of welding. This figure, however, does not include the various tack-welds which had to be taken into consideration, because each piece had to be tack-welded into place before the final joint was made. Each buoy required approximately 4 pounds of all-purpose bronze welding rod.*

A bit of experimenting in connection with the type of rod best for use on this job showed that bronze-welding saved the contractor about 70 percent of the amount of welding gases that was originally estimated the job would require. It also saved at least 50 percent of the estimated welding time.

After the job was completed and passed on by the inspector for the purchaser, the contractor found that he had realized a profit, in spite of the costs accruing through experimentation, breaking in six welding operators, buying new apparatus, building jigs, and generally setting up the shop for this production work. Naturally, a similar expenditure will not be required for future work and the contractor will be in an even better position to secure more work of this type.

* Oxweld No. 25M. Bronze Rod (Patented).

Conditions in Machinery Industries Improve

Visible evidence of renewed activity in nearly all branches of the machinery trade of the United States are among the soundest of indications that the country is in fact emerging from the depression, according to "Review of the American Machinery Industries" made public recently by the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Certain underlying factors, such as the delayed purchases of machinery and equipment and the existence of vast reserves of credit, point to definite expansion in the various machinery industries.

The significance of the machinery industries in the national economy of this country is indicated by the fact that in 1933, the latest period for which complete statistical data are available, the machinery industries, as a group, employed approximately 500,000 wage earners, paid more than $500,000,000 in wages, and produced commodities valued at approximately $2,000,000,000, according to the review. Although the machinery industries as a group have lost considerable ground since 1929, this group was ranked officially in 1933 as fifth in the number of establishments in the manufacturing field of the United States, fourth as to number of wage earners employed, and fifth as to the value of products.

Since 1933, the review states, the machinery business has improved vastly, employment is greater, pay rolls are larger, and the value of commodities is higher.

Proposed Revisions and Addenda to the A.S.M.E. Boiler Construction Code

It is the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the rules and its codes. Any suggestions for revisions or modifications that are approved by the committee will be recommended for addenda to the code, to be included later in the proper place in the code.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticism and approval from any one interested therein. It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the committee for consideration.

PARS. P-1 and U-12. Insert the following as (*c*) of these paragraphs:

Cast, forged or rolled parts of small size or which are ordinarily carried in stock and for which mill test reports or certificates are not customarily furnished may be used provided it has been demonstrated that they are suitable for the purpose intended.

PAR. P-9. Revise first sentence to read:

When the maximum allowable working pressure (See Par. P-179) exceeds 160 lb per sq in., cross-pipes . . . . shall be of wrought steel or cast steel [of Class B grade as designed] in ACCORDANCE WITH Specifications S-11 [for Carbon Steel Castings] or S-12.

PAR. P-11. Revise to read:

P-11. Pressure parts of superheaters separately fired or attached to stationary boilers, unless of locomotive type, shall be of wrought steel, puddled or knobbled charcoal wrought iron, or cast steel AS DESIGNATED IN SPECIFICATIONS S-11 OR S-12, OR ALLOY PIPE AS DESIGNATED IN SPECIFICATIONS S-33 (A.S.T.M. A 157), OR ALLOY STEEL CASTINGS AS DESIGNATED IN SPECIFICATIONS S-34 (A.S.T.M. A 158) [of Class B Grades as designated in the specifications.]

PARS. P-103*a* and U-71*a*. Add the following sentence:

All vessels constructed of plate conforming to Specifications S-26 and S-27, with or without the addition of molybdenum, shall be radiographed and stress relieved.

PARS. P-103*b* and U-71*b*. Modify proposed revision appearing n the May, 1936, issue of *Mechanical Engineering* to read as follows:

b Material for manhole frames, nozzles and other pressure connections which are to be joined to the shell or heads by fusion welding shall, when forged or rolled OR CAST comply with the specifications given for [shell] plates [and heads FORGINGS OR CASTINGS as to chemical and physical properties and be of good weldable quality.] [Cast steel or wrought steel nozzles may be used only when the material has been proved to be of good weldable quality. The carbon content in all such material shall not exceed 0.35 per cent.] SMALLER PARTS OF CAST, ROLLED, OR FORGED STEEL OF GOOD WELDABLE QUALITY MAY BE USED AS PROVIDED FOR IN PAR. P-1*c* (U-12*c*).

PAR. P-293. Revise first sentence to read:

When shut-offs are used on the connections to a water column, they shall be either outside-screw-and-yoke OR LEVER-LIFTING type gate valves or stop cocks with levers permanently fastened thereto and marked in line with their passage, etc.

PAR. P-299*d*. Revise to read:

d All valves and fittings on ALL FEED WATER PIPING AND WATER PIPING [water lines] below the water line shall be equal at least to the requirements of the American Standards for a pressure 25 percent in excess of the maximum allowable working pressure [except that for pressure over 100 lb per sq in., they shall be equal at least to the requirement of the American Standard for 250 lb per sq in.]

CAST-IRON VALVES OF INTERMEDIATE STANDARDS BETWEEN 125 LB AND 250 LB PRESSURE WHICH HAVE THEIR PRESSURE RATINGS PLAINLY MARKED ON THE VALVES MAY BE USED FOR THIS SERVICE UP TO 80 PERCENT OF THEIR RATED VALUE.

PAR. P-299*e*. Insert the following as the second section:

VALVES AND FITTINGS OF STEEL CONSTRUCTION EQUAL TO THE AMERICAN STANDARDS GIVEN IN TABLE A-6 MAY BE USED FOR MAXIMUM ALLOWABLE BOILER PRESSURES WHICH HAVE BEEN ADJUSTED AS FOLLOWS:

PRESSURES GIVEN IN AMERICAN STANDARDS FOR 750 F

100 300 400 600 900 1500

MAXIMUM PRESSURES AT WHICH BOILERS CAN BE OPERATED WHEN USING THE ABOVE STANDARD FLANGED FITTINGS OR VALVES FOR FEED AND BLOW-OFF SERVICE UNDER THIS PARAGRAPH AND PAR. P-310.

150 320 420 610 900 1400

PAR. P-302. Add the following:

CAST-IRON VALVES OF INTERMEDIATE STANDARDS BETWEEN 125 LB AND 250 LB PRESSURE WHICH HAVE THEIR PRESSURE RATINGS PLAINLY MARKED ON THE VALVES MAY BE USED FOR STEAM SERVICE UP TO THEIR RATED CAPACITY SUBJECT TO THE RESTRICTIONS OF PAR. P-12.

PAR. P-310. Revise (*d*) to read:

d For pressures exceeding 100 lb per sq in., the valves and fittings shall [be equal at least to the requirements of the American Standards given in Tables A-8 and

A-11 in the Appendix for 250 lb per sq in.] IF OF CAST IRON, BE EQUAL AT LEAST TO THE REQUIREMENTS OF THE AMERICAN STANDARDS FOR 250 LB AS GIVEN IN TABLES A-8 AND A-11; AND IF OF STEEL CONSTRUCTION SHALL BE EQUAL TO THE REQUIREMENTS OF THE AMERICAN STANDARDS AS GIVEN IN TABLE A-6, SUBJECT TO PAR. P-299*c*.

In (*e*), revise reference to "250 lb" to read "200 lb."

PAR. A-19. Modify proposed revision appearing in the April, 1936, issue of *Mechanical Engineering* to read:

A-19 *a*. Fire-actuated fusible plugs, if used, shall be filled [from the water side and to the point of least diameter of the hole in the casing] with tin of the following composition, having a melting point of between 400 and 500 F.

Pure tin, minimum, percent	99.3
Copper, maximum, percent	0.5
Lead, maximum, percent	0.1
Total impurities, percent	0.7

b THE FUSIBLE METAL SHALL EXTEND FROM THE WATER END OF THE PLUG TO THE POINT OF LEAST DIAMETER OF THE HOLE and [The filling] shall be carefully alloyed TO [with] the casing. TEST SHALL BE MADE TO DETERMINE THAT THE FUSIBLE METAL IS NOT LOOSE IN THE PLUG.

c The fusible plug shall be renewed at least once each year.

d When the boilers are operated at working pressures in excess of 250 lb per sq in., the use of fusible plugs is not advisable.

PAR. A-20. Modify proposed revision appearing in the April, 1936, issue of *Mechanical Engineering* to read:

A-20 *a*. Water-side plugs are fusible plugs which are inserted from the water side of the plate, flue, or tube to which they are attached. Fire-side plugs are fusible plugs inserted from the fire side of the plate, flue, or tube to which they are attached.

b The casing of the fusible plugs shall be made of bronze of the following composition:

	GRADE B	GRADE C
Copper, minimum, percent	84	86
Tin and Zinc, combined,[1] min. percent	9	10
Lead, maximum, percent	2.5	0.3

[1] Note: Zinc and lead may be reduced or eliminated if replaced by copper and tin.

c TYPICAL DESIGNS OF FUSIBLE PLUGS ARE GIVEN IN [The design of the casing shall be in accord with] Fig. A-10.

d The bore of the casing shall be tapered continuously [and evenly] from the water end of the plug FOR A DISTANCE OF AT LEAST 1 INCH to a diameter of not less than 3/8 in. [at a point 1/2 in. from the fire end.] The diameter of the bore ON THE WATER [at either] END shall not be less than 1/2 in. THE HOLE ON THE FIRE SIDE OF THE FUSIBLE PLUG SHALL BE AS LARGE AS POSSIBLE AND MAY BE OF ANY SIZE OR SHAPE PROVIDED THE CROSS-SECTIONAL AREA AT ALL POINTS IS GREATER THAN THE AREA OF THE LEAST CROSS SECTION OF THE FUSIBLE METAL.

e A fusible plug shall be of such length that when installed it shall project at least 3/4 [1] in. on the water side of the plate, tube, or flue and [as little as possible but not more than 1/2 in. on the fire side. If a fire-actuated fusible plug is inserted in a tube, the tube-wall shall be not less than 0.22 in. in thickness or sufficient to give four full threads.] IT SHALL EXTEND THROUGH THE PLATE, TUBE, OR FLUE ON THE FIRE SIDE AS LITTLE AS POSSIBLE BUT NOT MORE THAN 1/2 IN.

f A FIRE-SIDE PLUG MAY BE DESIGNED SO AS TO BE INSERTED BY MEANS OF A PLUG TYPE WRENCH, SO AS TO REDUCE THE PROJECTION ON THE FIRE SIDE.

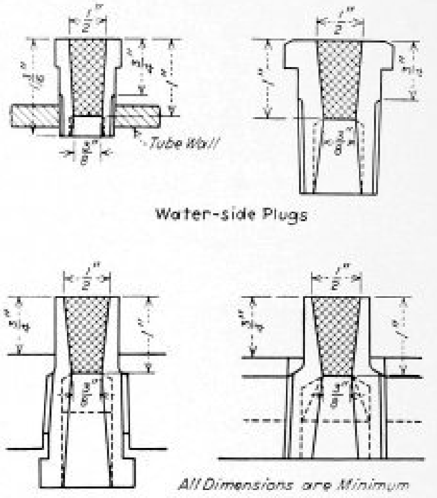


Fig. A-10

g THE MINIMUM LENGTH OF A FUSIBLE PLUG CASING SHALL BE 1 7/16 IN.

h IF A FIRE-ACTUATED FUSIBLE PLUG IS INSERTED IN A TUBE, THE TUBE WALL SHALL NOT BE LESS THAN .22 IN. THICK, OR SUFFICIENT TO GIVE FOUR FULL THREADS.

i FUSIBLE PLUGS WHICH COMPLY WITH THE REQUIREMENTS OF PARS. A-19 AND A-20 MUST BE STAMPED ON THE CASING WITH THE NAME OF THE MANUFACTURER, AND ON THE WATER END OF THE FUSIBLE METAL "A.S.M.E. STD."

Table A-10. Proposed addition published in April, 1936, issue of *Mechanical Engineering* rescinded.

PAR. L-10. Revise first sentence to read:

L-10. Water-leg and door-frame rings shall be of wrought iron or steel, or cast steel IN ACCORDANCE WITH SPECIFICATIONS S-11 [of Class A or Class B grade as designated in the specifications.]

The following table is the recommendation of the Subcommittee on Ferrous Materials:

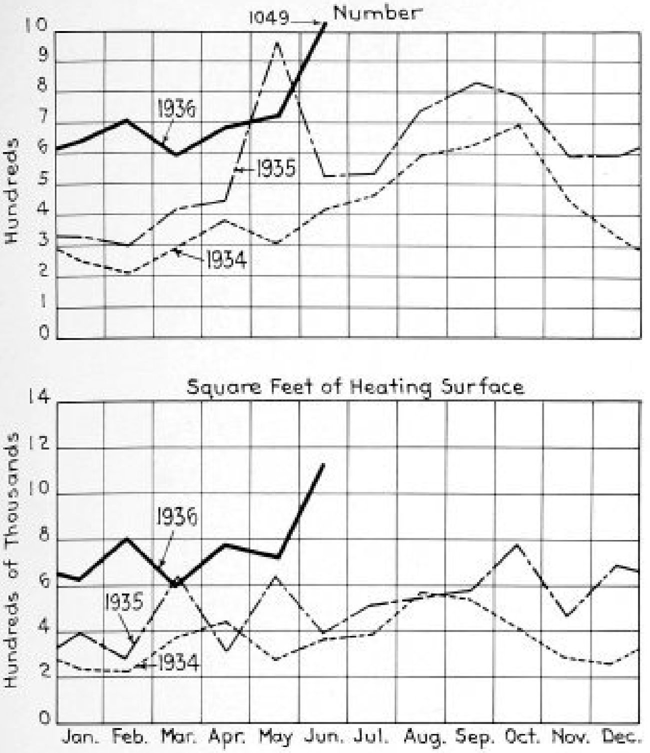
ALLOWABLE STRESSES AT ELEVATED TEMPERATURE FOR STEEL PLATE*

Temp., F.		S-1 (A-70) Flange, firebox	S-1 (A-70) Killed firebox	S-26 (A-149) S-27 (A-150) Grade A firebox	S-26 (A-149) S-27 (A-150) Grade B firebox	S-26 (A-149) S-27 (A-150) Grade A firebox .40-.60 Molyb.	S-26 (A-149) S-27 (A-150) Grade B firebox .40-.60 Molyb.
650	Flange and Firebox	11,000	11,000	13,000	14,000	13,000	14,000
675		10,800	10,800	12,760	13,680	13,000	14,000
700		10,400	10,400	12,160	12,840	13,000	14,000
725		9,800	9,960	11,280	11,640	13,000	14,000
750		9,240	9,480	10,400	10,560	13,000	14,000
775		8,640	8,960	9,560	9,560	12,870	13,780
800		8,000	8,440	8,800	8,800	12,400	12,800
825		7,320	7,880	8,000	8,000	11,630	11,800
850		6,680	7,240	7,240	7,240	10,800	10,800
875	Firebox Only	5,920	6,560	6,560	6,560	9,750	9,750
900		5,120	5,800	5,800	5,800	8,720	8,720
925		4,200	4,920	4,920	4,920	7,770	7,770
950		3,200	4,000	4,000	4,000	6,800	6,800
975		....	3,200	3,200	3,200	5,800	5,800
1,000		....	2,400	2,400	2,400	4,800	4,800

NOTE: Spec. S-1, killed, silicon = 0.15 to 0.25 percent; Spec. S-26 and S-27, minimum silicon = 0.15 percent.

* If no objections are received to this table it will be used as a basis for revising Table P-8.

Recovery in Boiler and Plate Industries



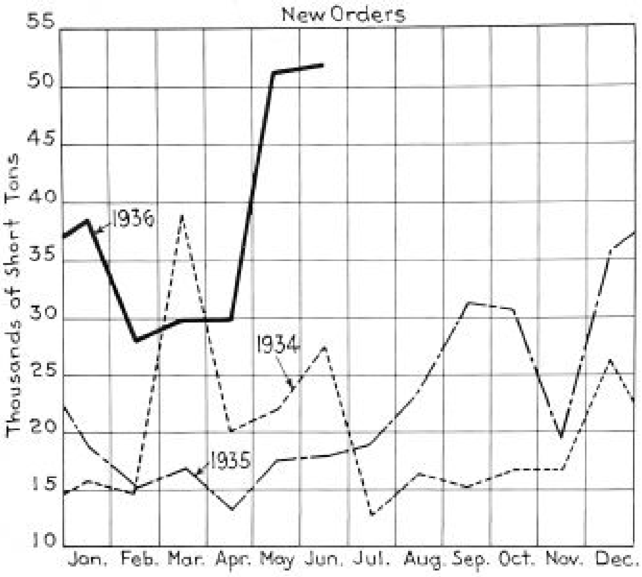
New orders for power boilers

The substantial recovery in power boiler production begun in 1935, continued at an increased rate during the first six months of this year. According to reports of the Bureau of the Census, Department of Commerce, based on data submitted by a group representing over 90 percent of the industry, there were 4390 power boilers, having a heating surface of 4,661,617 square feet produced during the first six months of the year. This record compares with 2973 units of 2,673,633 square feet in the first six months of 1935, and 1854 units of 1,916,-

New Orders for Steel Boilers—Six months Total, 1934-1936

Item	1936 June	1936 May	1935 June	1934 June	Total, 6 months (January-June) 1936	Total, 6 months (January-June) 1935	Total, 6 months (January-June) 1934
GRAND TOTAL:							
Number	1,049	721	524	415	4,390	2,973	1,854
Square feet	1,130,886	723,343	392,345	359,759	4,661,617	2,673,633	1,916,050
STATIONARY:							
Total:							
Number	401	298	193	168	1,643	941	829
Square feet	795,538	530,627	239,193	255,822	3,206,226	1,732,835	1,455,620
Watertube							
Number	145	64	40	43	485	295	252
Square feet	533,703	339,884	129,899	141,166	2,234,969	1,309,998	999,273
Horizontal return tubular							
Number	71	49	51	53	262	166	184
Square feet	101,349	75,003	67,788	68,085	348,009	203,090	245,783
Refractory-lined firebox return tubular							
Number	33	20	8	*	108	56	*
Square feet	30,415	17,400	5,640	*	96,018	52,987	*
Locomotive (not railway)							
Number	12	9	3	8	41	33	23
Square feet	13,930	3,196	1,545	6,435	36,560	19,007	16,995
Scotch type							
Number	18	12	6	*	88	25	*
Square feet	22,420	7,293	3,432	*	66,325	8,898	*
Self-contained portable							
Number	39	21	17	25	134	76	132
Square feet	23,486	21,320	8,173	26,867	100,381	46,942	99,852
Vertical fire tube							
Number	34	75	56	32	299	248	185
Square feet	9,486	15,463	14,632	10,481	69,785	59,656	52,792
Oil country							
Number	45	44	11	1	210	30	39
Square feet	54,749	50,549	7,964	1,264	238,874	29,442	31,674
Miscellaneous							
Number	4	4	1	6	16	12	14
Square feet	6,000	519	120	1,524	15,305	2,815	9,251
STEEL HEATING (as differentiated from power boilers):							
Number	639	416	323	234	2,672	1,966	948
Square feet	312,718	182,593	146,547	91,070	1,237,611	803,847	337,054
MARINE: †							
Total:							
Number	9	7	8	13	75	66	77
Square feet	22,630	10,123	6,605	12,867	217,780	136,951	123,376
Watertube							
Number	5	3	4	4	53	32	32
Square feet	21,110	9,163	5,188	7,512	208,990	117,202	96,664
Pipe							
Number	......	......	......	......	1	4	4
Square feet	......	......	......	......	935	4,955	3,569
Scotch							
Number	4	4	4	3	21	30	34
Square feet	1,520	960	1,417	373	7,855	14,794	15,258
Miscellaneous							
Number	......	......	......	6	......	......	7
Square feet	......	......	......	4,982	......	......	7,885

* Data not available.
† No boilers of the 2 and 3 flue type have been reported during any of the months specified in this report.



New orders for fabricated steel plate products

050 square feet in the same period of 1934. Not since 1931 has this industry enjoyed a comparable level of business.

The June figures of 1049 boilers, having 1,130,886 square feet of heating surface, would forecast a gain through the summer months when ordinarily a falling off in order might be expected. The June figures for 1936 compare with 721 units of 723,343 square feet in May, 1936; 524 units of 392,345 square feet for June, 1935, and 415 units of 359,759 square feet during June, 1934.

New Orders for Fabricated Steel Plate

Year and month	Total	Oil storage tanks†	Refinery material and equipment	Gas holders	Tank cars and blast furnaces	Miscellaneous
1936						
January	38,709	3,354	2,591	3,404	1,124	28,236
February	27,830	5,940	2,971	44	184	18,691
March	29,787	3,620	1,826	54	597	23,690
April	29,900	5,678	2,601	177	452	20,992
May	*51,257	9,311	*2,061	96	2,259	*37,530
June	51,999	21,861	4,485	433	3,080	22,140
Total (6 mos.)	229,482	49,764	16,535	4,208	7,696	151,279
1935						
January	18,778	1,389	1,202	167	710	15,310
February	15,064	2,531	1,156	503	318	10,556
March	16,832	2,377	965	456	87	12,947
April	13,244	2,152	877	399	271	9,545
May	17,630	3,690	821	347	102	12,670
June	17,914	1,872	1,994	1,030	293	12,725
Total (6 mos.)	99,462	14,011	7,015	2,902	1,781	73,753
July	18,890	4,193	1,615	573	35	12,474
August	23,628	3,505	2,599	531	769	16,224
September	31,105	3,531	3,061	74	245	24,194
October	30,530	5,850	3,081	334	292	20,973
November	19,116	2,617	2,620	8	176	13,695
December	35,584	9,341	5,327	173	724	20,019
Total (year)	258,315	43,048	25,318	4,595	4,022	181,332
1934						
January	15,897	3,754	480	880	271	10,512
February	14,641	2,476	1,337	216	160	10,452
March	38,924	2,202	2,495	65	356	33,806
April	20,085	2,998	2,338	1,174	128	13,447
May	21,891	8,746	1,767	445	131	10,802
June	27,395	11,019	1,359	382	993	13,642
Total (6 mos.)	138,833	31,195	9,776	3,162	2,039	92,661
July	12,523	2,028	946	737	911	7,901
August	16,293	3,334	1,452	548	104	10,855
September	15,108	3,445	2,305	62	1,078	8,218
October	16,581	927	2,280	158	659	12,557
November	16,629	3,252	2,673	263	189	10,252
December	26,025	5,185	2,710	1,609	1,203	15,318
Total (year)	241,992	49,366	22,142	6,539	6,183	157,762

* Revised.
† Reported as "Oil storage tanks (10,000 barrels and over)."

A complete summary of the comparative productions during the first six months for the last three years is published in the accompanying table:

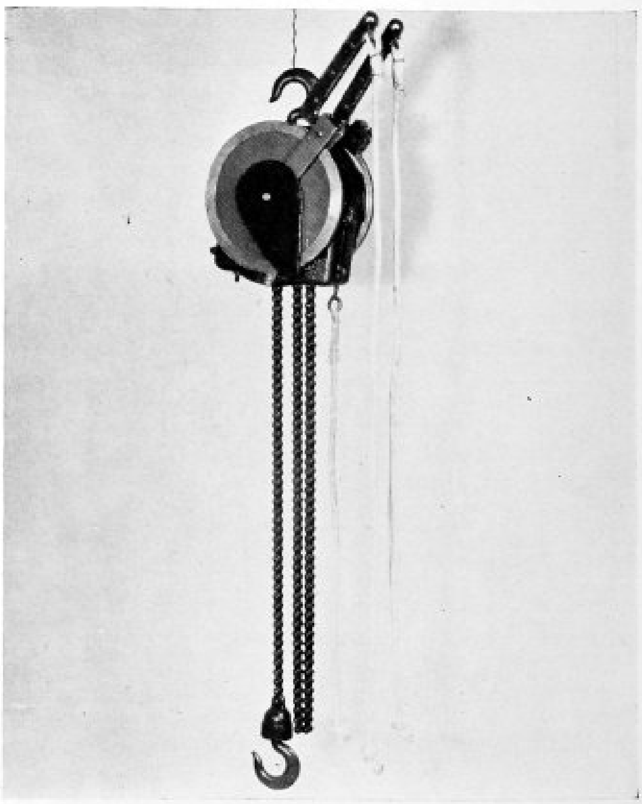
Steel Plate Fabricating Industry

In the steel plate fabricating industry only slightly less new orders were produced during the first six months of 1936, as compared with the total yearly production in 1935 and in 1934. New orders during the first six month period amounted to 229,482 tons, of which 49,764 tons were produced in the form of oil storage tanks, 16,535 tons in refinery material and equipment, 4208 tons in gas holders, 7696 tons in tank cars and blast furnaces, and 151,279 tons in miscellaneous heavy plate products. This latter figure would indicate a general rehabilitation of equipment coming under the category of heavy plate products generally throughout industry. The recovery, which has been noted in the heavy goods industries in the chemical, oil, and others, where the products of the plate fabricating industry are required, is evidently creating an increasing demand which must be supplied by concerns equipped to manufacture this form of equipment.

The six-month production of 229,482 tons compares with 99,462 tons during the same period of 1935 and 258,315 for last year's total. In 1934 the first six-month production was 138,833 tons, while the total yearly production was 241,992 tons.

Coffing Gravity Lowering Hoist

The Coffing Hoist Company, Danville, Ill., has recently perfected a type of hoist known as the Challenger, said to be the only spur-gear, twin-power, gravity-lowering chain hoist on the market. As shown in the illustration,



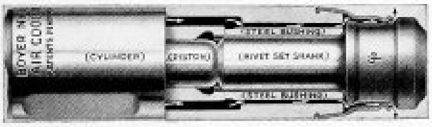
Coffing spur-gear, twin-power, gravity-lowering hoist this hoist is designed to be operated by rope pull on two levers which have a friction grip on the faces of two disk wheels, thus eliminating entirely the necessity for a hand-chain to lift the load.

The load is lowered by gravity to any position desired, the speed being entirely controlled by a simple governor arrangement. When there is no weight on the hoist, the slack in the load chain can be taken up by pulling on the loose end of the chain, or the chain can be pulled out free for quick adjustment by simply releasing the clutch, which also is rope-operated.

The Challenger is said to be fast, efficient and durable in operation. It is provided in four capacities, namely: ¼, ½, 1 and 2 tons. It is fully ball-bearing equipped and designed to operate with safety under 100 percent overload. In railway shop service, this type of hoist is a great time and labor saver when used for handling heavy parts, such as crossheads, pistons, rods, etc.

Air Cooling Incorporated in Boyer Hammer

The Chicago Pneumatic Tool Company, New York, has recently announced that the well-known Boyer riveting hammer manufactured by them now incorporates an air-cooling feature in ten different models, ranging from the light 15¾-pound hammer to the heavy 28½-pound type. The cooling system is shown in the illustration and the spaces through which the air passes



Chicago Pneumatic riveting hammer

and the direction of flow are indicated by the small arrows. Four air passages are provided in the gun and the air travels through these passages, coming in contact with the outer wall of the steel bushing holding the rivet set shank and the inner wall of the cylinder. The air is exhausted out around the nose of the hammer thus keeping that portion of the tool at a temperature which is claimed to reduce handling discomfort, contribute to increased life of the rivet set and allows for more continuous operation.

Another feature of this air-cooled hammer is the removable steel bushing holding the rivet set shank, which permits a higher degree of hardness in the internal nose end of the set shank.

Light Weight Welding Torch

The Modern Engineering Company, St. Louis, makers of Meco oxy-acetylene welding equipment, are in pro-

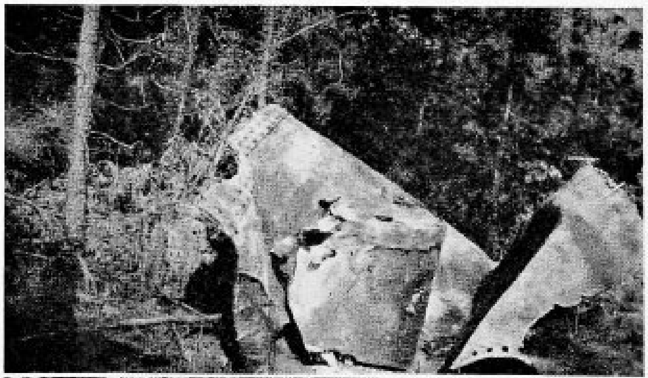
Weldmaster torch

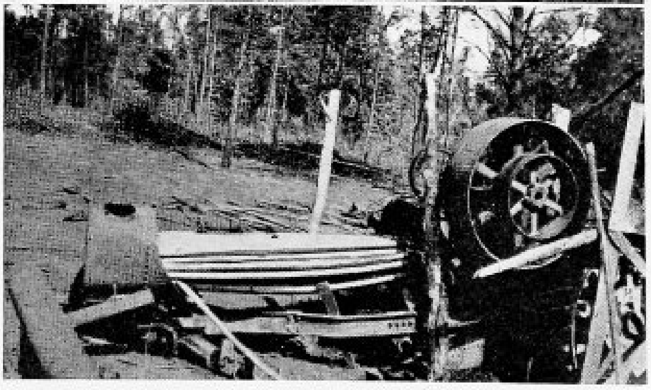
duction on their new Weldmaster ultra-light weight welding torch. This torch with a standard tip weighs only 17½ ounces, and is claimed by the makers to be the lightest weight torch on the market. A new alloy that can be forged, extruded and heat-treated and has a tensile strength of mild steel is used in the construction. According to the makers the torch is perfectly balanced as a result of weight elimination and can be manipulated by the operator with maximum flexibility and minimum effort.

The circle mixer employed in all Meco torches has been improved and its capacity increased. Even the largest tips may be used efficiently with low gas pressures, as when working from medium acetylene generators. A new method of boring passages to rifle smoothness has been developed in this torch. Ideal flame characteristics under any operating circumstances in the full range of welding practice are claimed.

Portable Sawmill Boiler Accident

One man was killed and another injured at a portable sawmill in Virginia, when a welded repair broke loose on a locomotive type boiler, causing a rupture the entire length of the longitudinal seam. The barrel of the boiler tore away at the front head and at the throat sheet, demolished the engine, and came to rest in the forest more than 400 feet away. The internal surface of the shell plate along the longitudinal seam was pitted and grooved throughout most of its length. In the middle of the joint was a ½-inch wide weld that had been applied externally parallel to the seam for about 2 feet, obviously to stop leakage, because the pitting and grooving had extended through the plate. The man who was killed was thrown more than 30 feet and the other workman sustained a broken leg and a scalded thigh. The boiler was uninjured.—*The Locomotive.*





Above—The barrel of the boiler where it came to rest 400 feet from the sawmill. Below—The remainder of the boiler, showing torn plate

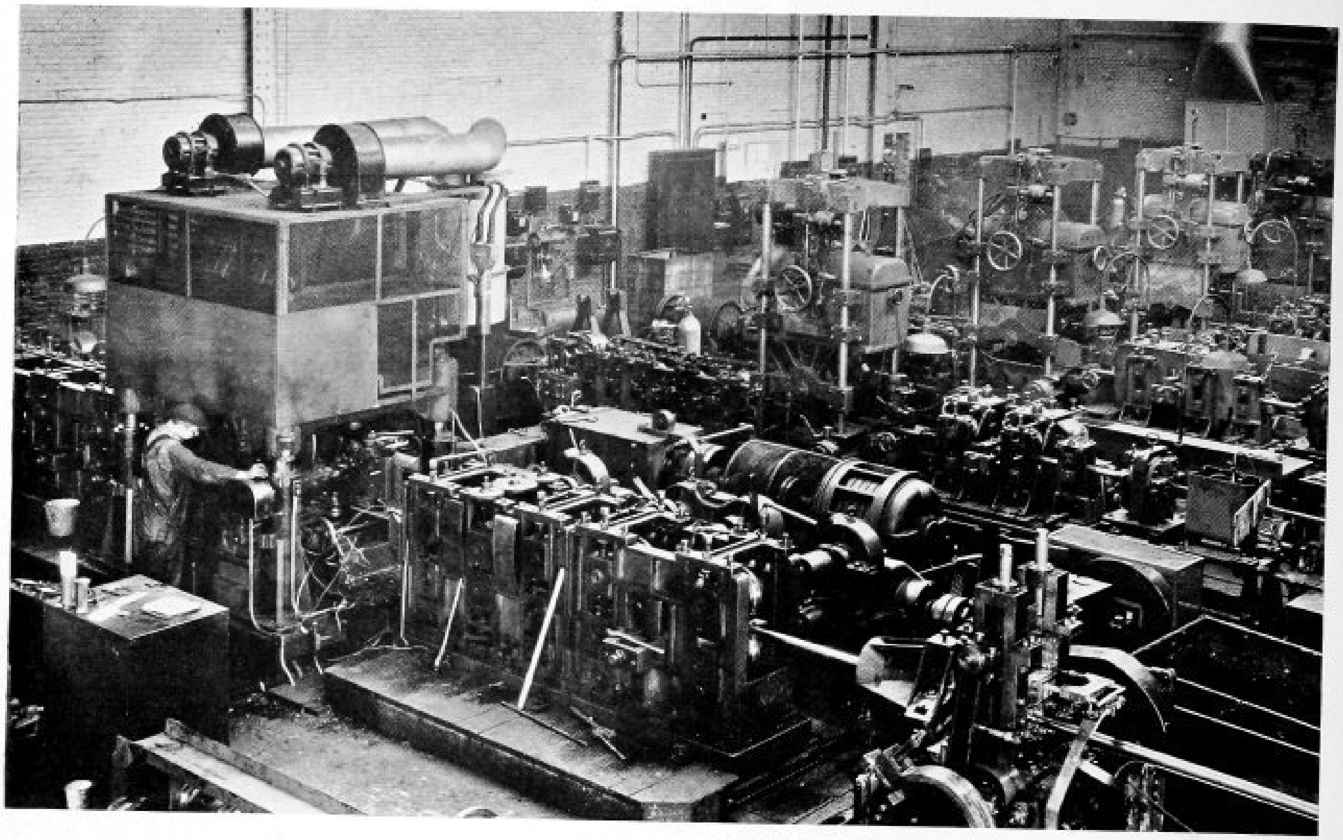


Fig. 1.—Mill room, showing Johnston electric weld tube mill in operation at left

Controlled atmosphere furnace for

Annealing Welded Boiler Tubes

The purpose of a controlled atmosphere furnace is to permit the heat treatment of metals at a temperature above the oxidizing point without formation of scale.

Controlled atmosphere furnaces have been in use for many years for heat treating ferrous and non-ferrous metals in various forms. Among some of the applications are annealing of copper tubing, copper brazing, heat treatment of razor blades and bright annealing of strip steel.

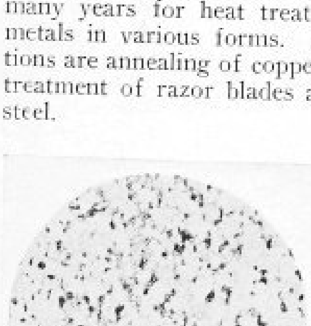


Fig. 2.—Photomicrograph of tube weld before annealing

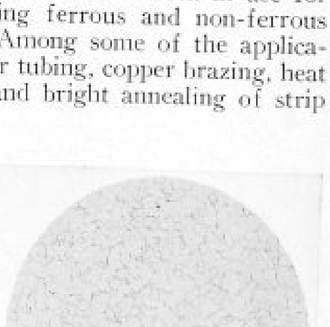


Fig. 3.—Tube weld after annealing in controlled atmosphere furnace

One of the first controlled atmosphere furnace installations for the continuous heat treatment of steel tubing was completed at the Cleveland Plant of Steel and Tubes, Inc., in September, 1935. This was primarily for the purpose of producing boiler tubing and other pressure tubing absolutely free of scale, without the necessity of pickling, although normalized above the upper critical point of the material (1650 degrees F.). The advantages of a tube entirely free from mill scale on both the inside and outside surfaces has long been recognized. If it were possible to obtain a tube on which the scale, or iron oxide, covers the entire surface of the tube with no possibility of any part of the scale or oxide breaking or chipping off during installation, or in service, it would be highly resistant to corrosion. However, it is not possible to obtain such a tube under existing methods of production.

Most steel boiler and pressure tubes are formed hot in open mills and scale is produced during the forming operation. Such scale is not uniform over the entire surface, and this provides an opportunity for selective corrosion, or pitting, due to electrolytic action caused by difference of potential between the iron oxide and the parent steel. There is also danger that such scale may cover up and hide defects in the steel.

Fig. 4.—New controlled atmosphere annealing furnace, showing hood to draw off escaping gases and exhaust

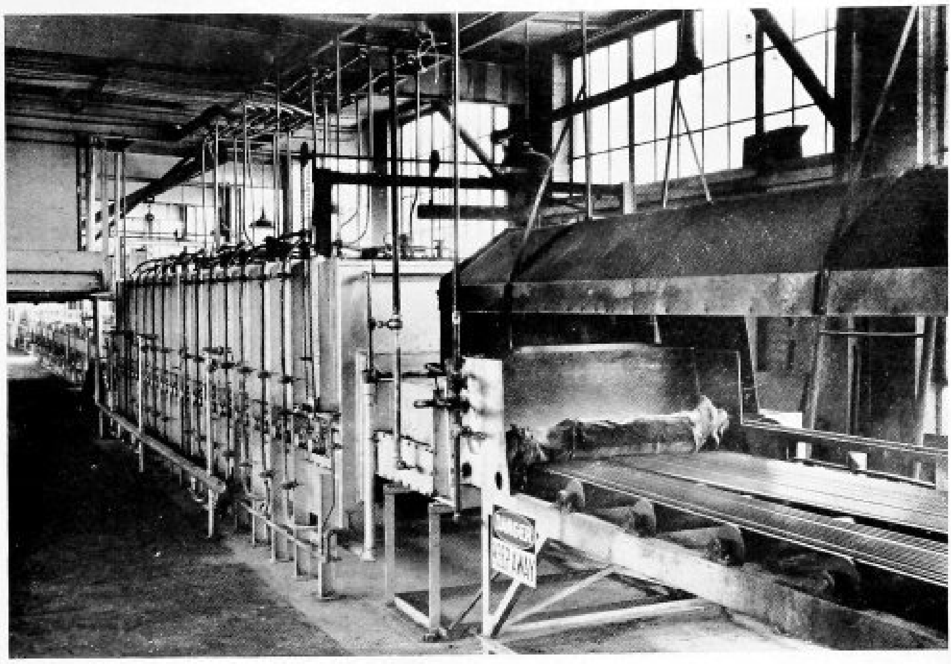
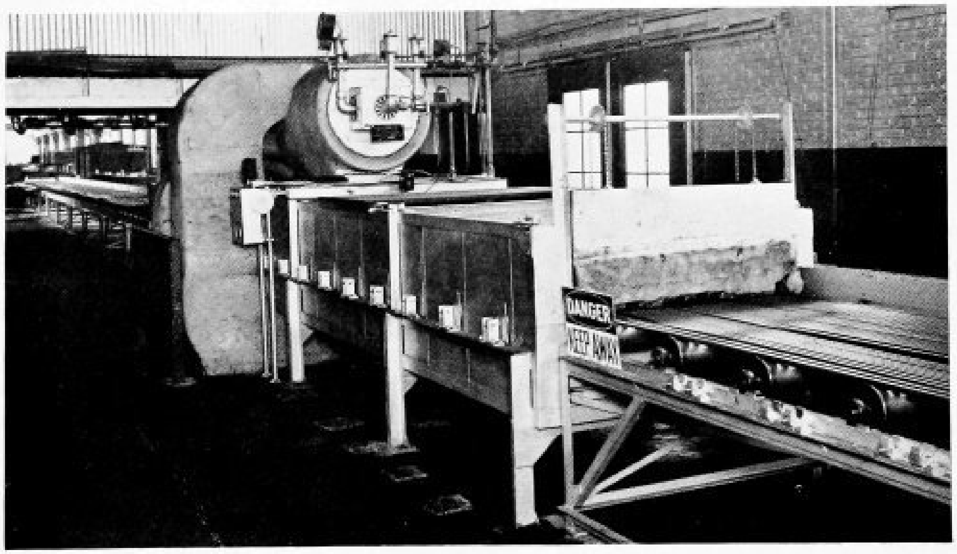
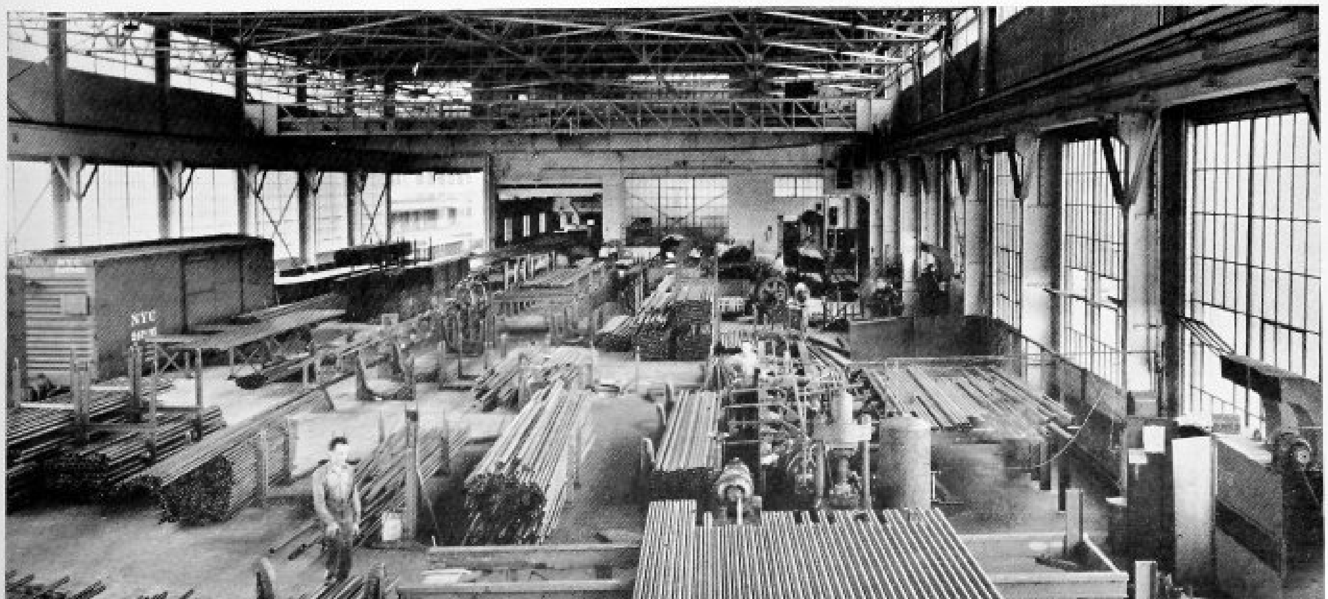


Fig. 5.—Gas fired blueing furnace which coats the tube surface with a fine blue protecting oxide. (Below), Fig. 6.—General view of shipping and testing room





Scale can be removed by pickling or sand-blasting, or in some cases by cold drawing. Many users, especially among the power companies, order boiler tubing with scale removed by one of these methods. A perfectly clean surface is probably even more important when the tube is used in refrigeration equipment, especially with those refrigerants which have a strong tendency to remove the scale from the surface of the tube, causing poor circulation in the unit, or even an actual obstruction in the line or mechanism. Tubes which are to be "Apexiorized" must be scale-free before the application of "Apexior"; a graphite base paint applied to the surface of a tube or boiler.

It has long been recognized that uniformity, not only of gage, but also of diameter, of surface inside and out, and of micro-structure and temper, is a very desirable feature in boiler and other pressure tubes. Due to the process of manufacture of electrical resistance welded tubing, this product seemed to possess all the essential features with a high degree of uniformity.

Wall thickness was uniform to within about 0.003 inch at any cross section. Diameter and out of round conditions were consistently uniform. The inside and outside of the tube was absolutely clean and free of scale. Micro-structure at the weld was slightly changed and the tube was slightly harder at the point of welding.

Johnston Tube Welding Process

The fundamentals of the Johnston welding process are undoubtedly familiar to most readers, and only a brief outline will be repeated here for those who are not conversant with it. Strip steel, carefully inspected on both sides and absolutely free of all scale, of accurate width (obtained by running the strip through a pair of rotating circular shears) is passed through a series of rolls of varying contour which make the flat stock into a butted tube. This butted tube is passed directly under a pair of copper disks which act as electrodes, one disk making contact with the surface of the tube on each side of the seam. The lower half of the tube, under the electrodes, is supported by a pair of steel rolls which exert pressure on the sides of the tubes at the instant of welding and force the edges of the seam together. Chemically the steel is not altered by the welding operation, as heat is generated by the resistance of the joint to the flow of an electric current, and no extra metal is added at the weld.

The Johnston process is continuous, which includes forming welding and sizing, immediately after the welding. The amount of metal extruded both inside and outside of the tube is very small, because the factors affecting the welding process; namely, pressure, temperature, contact and speed, have been so correlated that they weld the edges of the steel only. The heat does not penetrate into the body of the metal.

The slight upset or burr formed at the weld is removed by cutting tools inside and outside the tube. The cold rolling action in forming and sizing the tubes improves the original high-grade surface. Fig. 1 is an illustration of a Johnston welder used in the manufacture of boiler tubes.

The tube as it comes from the welder will stand up under all routine tests used in the factory, as well as the tests used in boiler tube specifications, without failure at the weld. Periodic samples are roller expanded with a standard roller expander and the tube is then flanged; test specimens are taken while the tube is being welded and the tests made immediately. If there is any indication of failure at the weld, the tube is rejected and no further tubing is produced until an adjustment has been made and a good weld obtained.

It was decided, in order to obtain uniformity of micro-structure and hardness, to normalize the "as-welded" tube at a temperature above the upper critical point of the metal, which in the case of boiler tube steel of 0.08 to 0.18 carbon is 1650 degrees F. Normalizing completely recrystallizes the steel, relieving all welding and cold working stresses and produces a uniform, fine grain micro-structure of uniform hardness. This heat treatment restores uniformity to such an extent that it is virtually impossible to locate the point of weld under the microscope. This is illustrated in Fig. 2, which shows the structure in the "as-welded" condition, and Fig. 3, which illustrates the same tube after normalizing.

However, by normalizing in an ordinary continuous electric furnace at 1650 degrees F., a light loose scale was formed which changed the bright scale-free surface of the original cold-worked as-welded tube. The tube was then pickled in order to remove this loose scale and produce a uniform scale-free surface.

This resulted in a tube with all the essential features of uniformity, in gage, in diameter, micro-structure, hardness and surface condition, but with not quite the same fine dense cold-rolled surface it had before being normalized and pickled.

Controlled Atmosphere Annealing Furnace

To preserve the fine finish and surface which results from cold working the original hot-rolled strip, the latest type of controlled atmosphere electric furnace was installed. This unit, which is said to be the largest of its kind ever made, is composed of the electric furnace proper and the cooling chamber. The furnace is of the roller hearth type, 36 feet long and 4 feet 4 inches wide across the rollers. The cooling chamber is water-jacketed so that the cooling rate may be controlled, and is directly connected to the furnace. This cooling chamber is approximately 78 feet long. The operation of the furnace is continuous. Tubes are carried through the furnace and cooling chamber on live rollers at the rate of 5000 pounds per hour.

A reducing gas, made by partially burning illuminating gas is passed through a refrigerating unit to remove all moisture, and is fed into the furnace to prevent oxidation at a rate which always keeps the furnace and cooling chamber slightly above atmospheric pressure, so all the leakage is outward. This leakage is burned at both the entrance and exit doors of the unit, hoods with exhaust fans being placed directly above the doors, to remove any traces of incompletely burned gases from the building. Automatic temperature controllers are used to maintain the desired temperature, which is approximately 1650 degrees F., which has been found to yield a steel of fine grain size, which, though ductile and easy to roll in, is tough and absolutely uniform in its physical properties. The length of the cooling chamber has been designed so that with the desired rate of cooling the tubes leave at a temperature below that at which scale will form. The result is a homogeneous tube of uniform grain structure and hardness, with all its original fine dense scale-free surface preserved intact.

Fig. 4 is a view of the entrance end of the furnace. Tubes may be seen on the roller hearth which is extended both before and after the furnace in the form of a roller conveyor for the tubing. The hood to remove any unburned leakage gas may be seen directly above the entrance to the furnace.

The tubes, after leaving the annealing furnace, continue on the roller conveyor across a space where they may be inspected or removed if a bright annealed tube is desired. Boiler and pressure tubes, however, are not removed at this point, but are allowed to continue on the roller conveyor through a blueing furnace, illustrated in Fig. 5. This blueing furnace is a gas-fired furnace kept at a temperature of approximately 650 degrees F., which imparts a very thin blue oxide coating to the tubes, similar to the blueing on a gun barrel. It was thought that this blueing would provide some measure of protection against rust in shipment and storage. This oven has been in use only a short time so that it has not been possible to observe its action throughout a yearly cycle of climatic changes, so it is not possible at present to evaluate accurately the effectiveness of this blue oxide coating as a rust preventative. The tubes continue on the roller conveyor through this blueing oven and into the boiler tube processing building, which was recently completed in order to take care of increased business in boiler and pressure tubes.

Production Methods Used

Equipment in the boiler tube building is arranged as nearly as possible for straight-line production with a minimum amount of handling between operations. The tubing is handled in lots, almost entirely by an overhead traveling crane. At the left of Fig. 6 may be seen the discharge end of the roller conveyor which passes through the annealing furnace and the blueing oven. The tubes, reaching the end of this table, are automatically thrown off into racks with semicircular bottom portions which arrange the tubes into a bundle which may be easily handled by the crane. The crane is equipped with double hooks and slings of braided wire rope which may be slipped under each end of a bundle of tubing in the rack. The tubes are lifted out of the rack by the crane and carried directly across the building to the straightening rolls, shown on the extreme right of the illustration.

Fig. 6 also gives a general view of the arrangement of various production equipment in part of the boiler tube building. The tubes, after leaving the straightening rolls, go to the lathe cut-off, where they automatically pass through and drop into another set of racks opposite the hydrostatic tester. The crane carries the tubes from this point to the table back of the tester whence they fall by gravity, one at a time, onto tables for visual inspection and stenciling, according to A.S.M.E. specifications. From here the tubes go either directly to cars, which are on a siding within the building, or are carried by the crane further back into the building for storage.

The racks, Fig. 7, used in this storage are of interest because they provide not only storage space but also a means of handling the tubing. Each rack is composed of two separate "U" shape units, composed of two vertical members and one cross member. The vertical members are square tubular sections with drop forgings welded in the top. The drop forgings are tapered and provided with slots for the crane hooks. The crane is equipped with a special handling device of four hooks, each pair of hooks taking one of the individual "U" racks and accurately spacing them. Each pair of racks may be nested on top of another rack. These racks provide not only a convenient method of handling the tubes, but provide a storage system which requires a minimum amount of space, because the racks may be lifted off at any time by the crane and no space has to be left at the ends in order to remove the tubes.

Because of the care and refinement of the processes used Electrunite tubes produced by the company have been accepted almost universally by organizations which control the construction and operation of boilers. Case 709 (revised) has been acted upon by the Boiler Code Committee of the American Society of Mechanical Engineers to cover electric resistance welded boiler tubes. They are included in Federal specifications WW-T-731a, issued by the Federal Specification Board, and can be used in either water or fire tube boilers under the rules and regulations of the Bureau of Marine Inspection and Navigation. Both Lloyd's Register of Shipping and the American Bureau of Shipping have accepted electric resistance welded boiler tubes for both fire and water-tube boilers, and practically all insurance companies insure boilers with Electrunite Tubes.

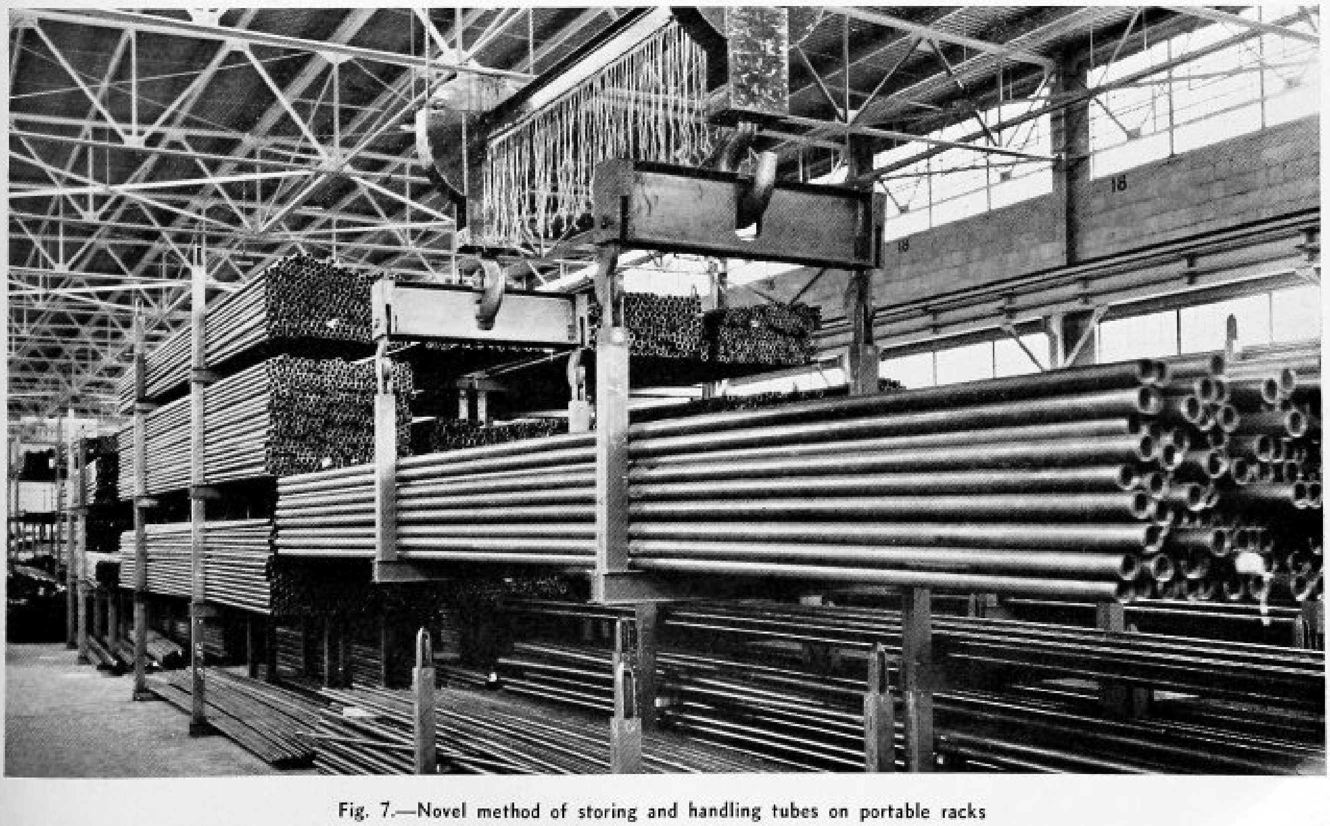


Fig. 7.—Novel method of storing and handling tubes on portable racks

Practical Plate Development — XVI

Oblique Pipe Intersections

By George M. Davies

The oblique pipe intersection to be developed, consists of two parallel pipes, one above the other, but not in a vertical plane. The connecting pipe joins the upper parallel pipe some distance behind the intersection with the lower pipe as shown in the elevation, Fig. 136, and the plan view, Fig. 137.

The connecting pipe consists of three cylindrical sections as "*A*," "*B*" and "*C*" in the elevation, Fig. 136. Sections "*A*" and "*C*" are in a vertical plane to the parallel pipes, the center line of section "*A*" being the vertical center line of the lower pipe, and the center line of section "*C*" being the vertical center line of the upper pipe. To connect the vertical sections "*A*" and "*C*," section "*B*," having the same diameter as sections "*A*" and "*C*" is run obliquely from "*A*" to "*C*." It is projected at an angle of 45 degrees in both the elevation and plan views.

In order to simplify the layout, the thickness of the plates is not shown, the layout being made on the neutral axis of the plates. The pipes will be considered to have all welded joints.

Development of the Sections

It is first necessary before proceeding with the development of sections "*A*," "*B*" and "*C*" to obtain the true relationship between the sections, and to show section "*B*" in its true size and the angles it makes with sections "*A*" and "*C*"; also to show the true miter lines between all the sections, so that when the patterns are developed and assembled in their proper position they will all fit properly and make the desired connection.

In Fig. 138, draw any line as m-n, parallel to the line G-H of the elevation and on m-n step off the distance E''-F'', equal to the distance E'-F' of the plan view, Fig. 137. At E'' and F'', Fig. 138, erect perpendiculars and then parallel to the line G-H draw lines through the points E and F of the elevation, cutting the perpendiculars just drawn locating the points E° and F°. Connect E°-F°, this line being the true length of the center line of the section "*B*."

At E'' and F'', Fig. 138, draw the profiles of sections "*A*" and "*C*" and extend same into the view above. Next, bisect the angles E''-E°-F° and E°-F°-J, Fig. 138, obtaining the miter lines J-K and L-M, J-K-L-M being the true size of section "*B*."

To Develop Section "A"

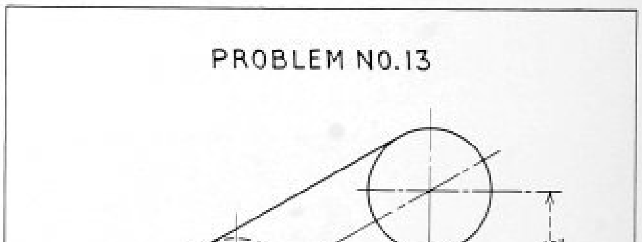
Divide the profile at "*E*," Fig. 138, into any number of equal parts, the greater the number of equal parts taken the more accurate the final development, eight being taken in this case. Number these intersections from 1 to 8 as shown. Then parallel to E''-E° draw lines through the points 1 to 8 extending same cutting the line J-K at 1′ to 8′.

Then in the plain view, Fig. 137, divide the profile at E' into the same number of equal parts as was taken for Fig. 138 and number same from 1 to 8 corresponding to the points 1 to 8, Fig. 138, as shown.

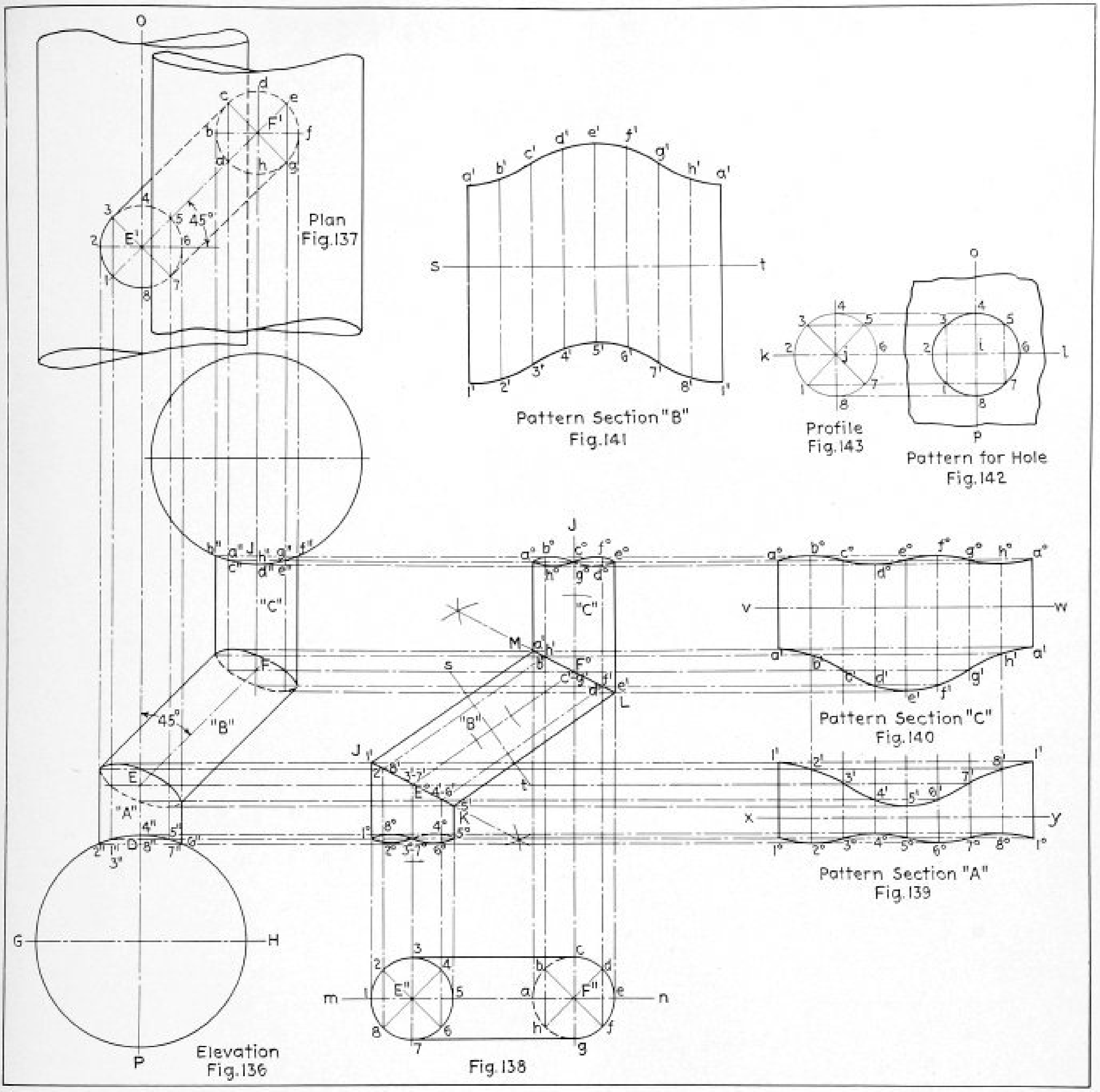
Next parallel to the center line O-P draw lines through the points 1 to 8, Fig. 137, extending same into the elevation cutting the circumference of the large pipe at 1″ to 8″, Fig. 136.

Parallel to the line E-E° draw a line through point 1″, Fig. 136, and extend same into Fig. 138, cutting a line drawn perpendicular to m-n through the point 1 locating the point 1°, Fig. 138. In like manner, draw a line through point 2″, Fig. 136, and extend same into Fig. 138, cutting a line drawn perpendicular to m-n through the point 2, locating the point 2°, Fig. 138. Continue in this manner, locating the points 3°, 4°, 5°, 6°,

Problem No. 13 for Readers to Lay Out



The correct solution of Problem No. 13 will be published in the November issue



Details of layout for an oblique pipe intersection

7° and 8°. Connect the points 1° to 8° with a line, completing section *"A,"* Fig. 138. This section is now shown in its true size.

Pattern Section "A"

Adjacent to section *"A,"* Fig. 138, draw any line *x-y*, Fig. 139, parallel to *m-n* and on *x-y* step off the same number of spaces as was taken for the profile at *E″*, Fig. 138. Erect perpendiculars to *x-y* through these intersections, extending same above and below *x-y*, Fig. 139.

Parallel to *x-y* draw lines through the points 1′ and 1°, Fig. 138, extending same into Fig. 139, cutting the first perpendicular locating the points 1′, 1°, Fig. 139; then parallel to *x-y* draw lines through the points 2′ and 2°, Fig. 138, extending same into Fig. 139, cutting the second perpendicular locating the points 2′, 2°, Fig. 139.

Continue in this manner, locating the points 3′, 3°, 4′, 4°, 5′, 5°, 6′, 6°, 7′, 7°, 8′, 8° and 1′, 1° as shown. Connect these points with a line completing the pattern of section *"A."*

To Develop Section "C"

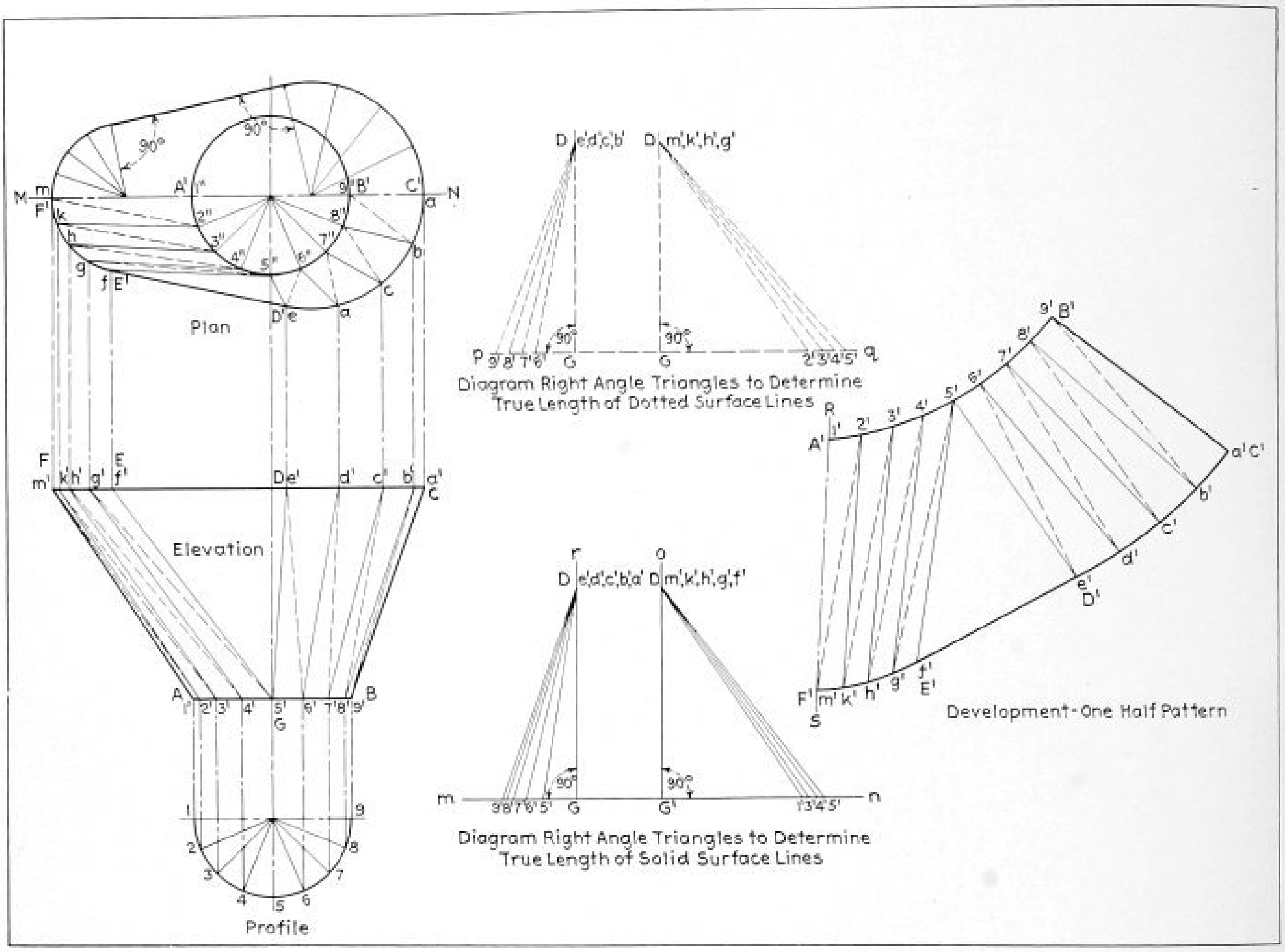
Divide the profile at *F″*, Fig. 138, into the same number of equal parts as was taken for the profile at *E″*, Fig. 138. Number these intersections from *a* to *h* as shown. Then parallel to *F″-F°* draw lines through the points *a* to *h*, extending same cutting the line *L-M* at *a′* to *h′*.

In the plan view, Fig. 137, divide the profile at *F′* into the same number of equal parts as was taken for Fig. 138 and number same from *a* to *h* corresponding to the points *a* to *h*, Fig. 138, as shown.

Next parallel to the center line *O-P* draw lines through the points *a* to *h*, Fig. 137, extending same into the ele-

Problem No. 12 — Correct Layout

Sand Bucket



Problem No. 12 was published on page 147 of the June issue. Above is the correct layout of this problem which may be used by readers to check their solutions

vation cutting the circumference of the upper large pipe at a'' to h'', Fig. 136.

Parallel to the line F-F°, draw a line through point a'', Fig. 136, and extend same into Fig. 138, cutting a line drawn perpendicular to m-n through the point a locating the point a°, Fig. 138. In like manner, draw a line through point b'', Fig. 136, and extend same into Fig. 138, cutting a line drawn perpendicular to m-n through the point b, locating the point b°, Fig. 138. Continue in this manner, locating the points c°, d°, e°, f°, g°, and h°. Connect the points a° to h° with a line completing section "*C*," Fig. 138. This section is now shown in its true size.

Pattern Section "C"

Adjacent to section "*C*," Fig. 138, draw any line v-w, Fig. 140, parallel to x-y and on v-w step off the same number of spaces as was taken for the profile at F'', Fig. 138. Erect perpendiculars to v-w through these intersections, extending same above and below v-w, Fig. 140.

Parallel to v-w draw lines through the points a' and a°, Fig. 138, extending same into Fig. 140, cutting the first perpendicular locating the points a', a°, Fig. 140; then parallel to v-w draw lines through the points b' and b°, Fig. 138, extending same into Fig. 140, cutting the second perpendicular locating the points b', b°, Fig. 140.

Continue in this manner, locating the points c', c°, d', d°, e', e°, f', f°, g', g°, h', h°, a' and a° as shown. Connect these points with a line completing the pattern of section "*C*."

Pattern Section "B"

Draw any line as s-t, perpendicular to the center line E°-F°, Fig. 138.

Next draw any line s'-t', Fig. 141, and on same step off the same number of spaces as was taken for the profiles in Fig. 138. Erect perpendiculars to s'-t' through these intersections, extending same above and below s'-t', Fig. 141.

On the first perpendicular step off above the line s'-t', a distance equal to the distance from the line s-t to the point a', Fig. 138, locating the point a', Fig. 141, and then step off below the line s'-t', a distance equal to the distance from the line s-t to the point 1′, Fig. 138, locating the point 1′, Fig. 141.

On the second perpendicular step off above the line s'-t', a distance equal to the distance from the line s-t to the point b', Fig. 138, locating the point b', Fig. 141, and then step off below the line s'-t', a distance equal to the distance from the line s-t to the point 2′, Fig. 138, locating the point 2′, Fig. 141.

Continue in this manner, locating the points c', 3′, d', 4′, e', 5′, f', 6′, g', 7′, h', 8′, a', 1′, Fig. 141. Connect all the points with a line completing the pattern of section "B."

Pattern for Hole in Pipe

Draw any line as k-l, Fig. 142, at j draw profile Fig. 143 as in profile at E', Fig. 137.

Next, at i draw the perpendicular o-p. Then on k-l, each side of o-p, step off the distance 4″-5″, Fig. 136; draw lines parallel to o-p through these points extending same above and below k-l. Then draw lines parallel to k-l through the points 3, 5, 1 and 7, Fig. 143, cutting the lines just drawn, locating the points 3, 5, 1 and 7, Fig. 142.

Next, on k-l step off the distance i-2 and i-6 equal to the distance 4″-6″, Fig. 136, locating the points 2 and 6, Fig. 142. Connect the points 1, 2, 3, 4, 5, 6, 7, 8, Fig. 142, with a line completing the pattern for the hole in the pipe. Due to the fact that the intersections with the top and bottom pipes are identical, this layout is suitable for both top and bottom connections.

(To be continued)

Accident Rate in Metal Industries

Reductions in both accident frequency and accident severity were made in the miscellaneous metal products industries during 1935, in comparison with 1934, according to reports of the National Safety Council.

These reports were assembled from 158 plants whose employes worked 125,799,000 man-hours. The average frequency rate of 14.06 (the number of disabling injuries per million man-hours of exposure) is 4 percent below the rate for 1934; and the corresponding average severity rate of 1.03 (the number of days lost per thousand man-hours of exposure) is 24 percent under the rate for 1934.

These rates may be compared with the average rates for 30 major industries reporting annually to the council, which show 14.02 for accident frequency and 1.58 for accident severity. Miscellaneous metal products therefore rank seventeenth in frequency of accidents and tenth in severity, being tied for the latter position with the chemical industry.

The frequency of disabling injuries has decreased 62 percent since 1926, in comparison with a reduction of 61 percent for all industries; in severity, the improvement is 47 percent, which is also larger than the average reduction of 43 percent for all industries.

1935 injury rates were again lowest in large units. Small plants, however made the largest improvement in comparison with 1934.

Jewelry manufacturers had the lowest frequency rate averaging 7.16, and manufacturers of chain had the lowest severity rate, 0.38. Structural steel fabricators made the largest reduction in frequency in comparison with 1934—32 percent; the largest improvement in severity was made by boiler shops—75 percent.

The most important types of compensable accidents in miscellaneous metal products industries according to state reports, are "machinery" and "handling objects" which account for 58 percent of all types.

Metal products industries made the best showing in severity, when compared with other industries. Frequency about equals the average for all industries but severity rates are 35 percent lower. Miscellaneous metal products plants have made more progress in reducing injury rates, on the whole, than have other metals industries.

During the last two years, companies having fatalities or permanent partial disabilities have been requested to make special reports on the circumstances involved in such injuries so that better information could be developed on the fundamental causes of serious accidents in the industry. Summary reports for the last two years have listed 243 serious injuries and 69 of these cases have been reported in detail. An analysis of the circumstances involved in them discloses:

1. Machine operators were involved in more than one-half of the serious injuries. The remaining cases were distributed among numerous other occupations, of which laborers, repairmen, supervisors, inspectors, and technical employes had five or more each.

2. Machinery was by far the principal agency of injury, being involved in 39 cases. Presses, as in other industries where they are used extensively, figured in more accidents than other types of machinery. Two or more serious injuries also occurred on shears, saws, wire drawing machines, and lathes. The handling of steel shapes and plates also brought about several serious injuries.

3. The principal type of accident was "caught in or between." Most of these accidents occurred when employes were working with machinery in motion.

The second important type of accident was "falling, sliding, flying objects." Such accidents occurred often when employes were carrying materials by hand, lifting objects, or handling materials by means of cranes.

4. "Hazardous arrangement" was assigned as the principal mechanical cause in 14 serious injuries.

5. The principal personal cause was wrong attitude such as chance taking, and disregarding instructions.

Internal Feed Pipe Connections

By G. P. Blackall

Many of the so-called "mysterious" substances of rapid corrosion in marine boilers can be traced to the presence of air in the feed water. It is fairly well known that it is very undesirable to liberate comparatively cold and aerated feed water until it is near the waterline of the boiler. In order to achieve this internal feed pipes are fitted, but it is not so generally recognized that the point where these pipes are connected to the internal cock of the feed check valve should be frequently and carefully examined for any sign of leakage. If any leakage does occur at this point, air entering with the feed water will be liberated and serious corrosion of the end plates is likely to occur.

The importance of these internal joints is not always appreciated, even by the makers of the boilers, it being assumed that because there is no pressure difference a firm attachment is not essential. Various methods of attaching internal feed-water pipes to the shell are employed, but the jointing surfaces should be carefully

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

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BUSINESS MANAGER: Warner Lumbard.

Contents

faced up and given a thin coat of red lead paint before being put together. It is undesirable to use jointing material, because the pressure exerted by the stud bolts provided is insufficient to prevent water percolating through any other than a solid joint.

Internal feed pipes should always be held in position by clips independent of the joint to the shell, so that this joint is relieved of all strain. In their passage to the upper part of the boiler they should be secured at least ½ inch clear of smoke and stay tubes, otherwise serious damage by chafing may be caused.

Vertical Tubular Boiler Explosions

The explosion of a 48-inch diameter vertical tubular boiler at a New Jersey laundry caused the death of a watchman and an oil burner mechanic and the severe injury of a boiler maker on January 17, 1936, as they were making repairs to the burner. The upper tube sheet bulged outwardly, breaking away from the tube ends and projecting the stack and breeching upward. The explosion blew off the roof, and broke a large plate glass window about 80 feet from the boiler. The men were blown against the wall of the boiler room and were sprayed with burning oil. This accident was attributed to low water and overheating in a vessel which, it was reported, was not covered by insurance.

* * *

The explosion of a vertical tubular boiler 30 inches by 7 feet at a Southern ice cream plant damaged three buildings. There was no evidence of over-heating, and the accident was attributed to operation of the boiler at a pressure in excess of that for which it was built. The boiler traveled about 10 feet after the furnace sheet failed.—*The Locomotive.*

A.S.T.M. Officers, 1936-1937

The American Society for Testing Materials announces the following officers for 1936-1937, elected at its annual meeting, Atlantic City, June 30; President, A. C. Fieldner, Experiment Station Division, U. S. Bureau of Mines, Washington, D. C.; vice-president, T. G. Delbridge, manager, research and development department, The Atlantic Refining Co., Philadelphia.; member of executive committee, O. U. Cook, assistant manager, department of metallurgy, inspection, and research, Tennessee Coal, Iron, and Railroad Company, Birmingham, Ala.; H. F. Gonnerman, manager, research laboratory, Portland Cement Association, Chicago, Ill.; C. S. Reeve, manager, research development, The Barrett Company, Leonia, N. J.; F. E. Rickart, research professor of engineering materials, University of Illinois, Urbana, Ill.; and F. W. Waring, engineer of tests, The Pennsylvania Railroad Company, Altoona, Pa.

H. C. Mann, senior materials engineer, Ordnance Department, U. S. Government, Watertown Arsenal, was awarded the Charles B. Dudley Medal for 1936, for his paper "The Relation Between the Tension, Static, and Dynamic Tests."

A.S.M.E. Niagara Falls Meeting, September 17 to 19

Current practice in power plants will be the topic discussed in many of the papers to be presented September 17-19 at the Niagara Falls meeting of The American Society of Mechanical Engineers.

Because of the presence in this country of many engineers from abroad, who will be in attendance at the World Power Conference, to be held in Washington, D. C., September 7-12, the opportunity has been seized to secure papers on foreign as well as American practice, and to build up a program that will draw out discussion from engineers of all countries.

The program for the World Power Conference provides four technical inspection tours following the Washington sessions. Each of these tours is built up around a special subject—power, hydraulics, fuels, and transportation. Each will visit Niagara Falls; the power and hydraulics tours, will be there on September 17 and 18, the transportation on September 17, and the fuels on September 18. For this reason, the presentation of papers at the A.S.M.E. meeting will be confined to these two days.

In addition to subjects relating to power, papers at the Niagara Falls meeting will deal with many others, including transportation, and the processing and wood industries.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Smokebox Air Leaks

Q.—Having been a subscriber to *Boiler Maker and Plate Fabricator* for a number of years, I would like to have some information regarding the following question: I work as a boiler maker at the C.P.R. roundhouse, Sutherland. Very often we have engineers who report their engines "not steaming, test front end." It is the boiler maker's work to make a hydraulic test of the steam and superheater pipes and exhaust pot joint. Very often we do not find any leaks, but it is evident that there must be moisture forming in the front end as the front end netting is more than half plugged with cinders. Not finding any water leaks, I usually make a test for air leaks around where the steam pipes pass through the smokebox from the superheater header to the valves; also joints between smokebox front, door and smokestack. I make this test by connecting the shop blower to the engine and using a torch. If there is a leak, the suction draws the lighted torch to the opening. I maintain that these air leaks partially check the draft on the fire thereby reducing the temperature in the firebox, and that the difference in the temperature of the air drawn through these openings and gases in the smokebox cause a moisture and thereby plug the front end netting, which affects the steaming of the engine. The foreman here differs with me and maintains that it is only a minor detail and is not worth mentioning. Now I believe that this must be the case, but to make these repairs it would take four or five hours of the machinist's time. But if he gave up the train on account of insufficient steam, it is the boiler maker who has to explain as to the cause of failure and at the same time protect his fellow workmen.

What I would like to know is if there is a formula whereby one could determine the pull on the fire (pounds per square inch) if a locomotive had a front end that had no air leaks, and then the percentage of loss of the pull if there were several square inches of openings? I have explained matters fully and hope you can give me something on this matter by which I can substantiate my statement or otherwise. The question is based on the facts that the draft plates in the front end are installed correctly to the company's specifications. W.A.H.

A.—Air leaks in the smokebox do affect the steaming of the engine. I do not have any formulæ whereby one can determine the pull on the fire (pounds per square inch) if a locomotive had a front end that had no air leaks, and the percentage of loss of the pull if there were several square inches of opening. Tests conducted by the United States Railroad Administration indicate that draft inefficiency is caused to a great extent by air leaks in the front end, especially in superheated steam locomotives with steam pipes extending through the smokebox. As a rule, in order to permit easy application and removal, the hole through the smokebox is cut large enough to accommodate the flange of the pipe. This opening is then partially closed by means of a split collar or bushing. In practically all locomotives built prior to 1918 this collar or bushing left an opening around each pipe equal to a round hole 5¾ inches in diameter. As a result, when the exhaust creates a partial vacuum in the front end, some air moving along the line of least resistance will be drawn in through these openings instead of through the fuel bed. The draft is thereby decreased by that amount, making it necessary to reduce the nozzle in order to maintain the necessary vacuum. Tests have proven that sealing these openings permitted an increase of from ¼ inch to ⅜ inch in the diameter of the exhaust nozzle, resulting in a decrease of from 14 to 21 percent in fuel with a corresponding increase in engine efficiency, at the same time very materially improving the locomotive steaming qualities.

Weldless Boiler Braces

Q.—What advantages, if any, are obtained by using weldless boiler braces? F. N. J.

A.—The weldless boiler brace generally consists of a brace rod and foot attaching the brace to the boiler shell. A typical weldless type boiler brace is illustrated in Fig. 1.

The rod is forged without welds. The jaw on the end of the rod is usually formed in a forging machine and the

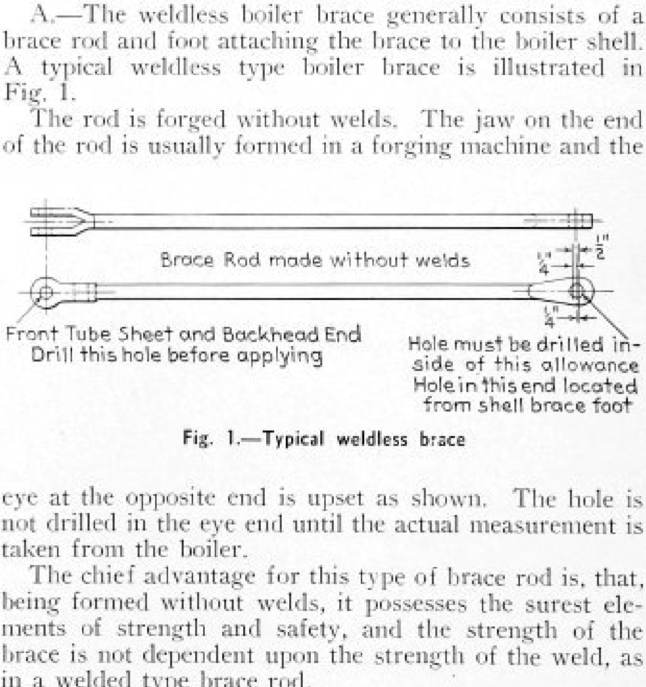


Fig. 1.—Typical weldless brace

eye at the opposite end is upset as shown. The hole is not drilled in the eye end until the actual measurement is taken from the boiler.

The chief advantage for this type of brace rod is, that, being formed without welds, it possesses the surest elements of strength and safety, and the strength of the brace is not dependent upon the strength of the weld, as in a welded type brace rod.

The A.S.M.E. Code provides for maximum allowable stresses in braces as follows:

(1) Unwelded braces and unwelded portions of welded braces for lengths between supports not exceeding 120 diameters, 9500 pounds per square inch and for lengths between supports exceeding 120 diameters, 8500 pounds per square inch.

(2) Welded portions of braces, 6000 pounds per square inch.

From the above it can be seen that for a given load, a smaller diameter weldless type brace rod could be used than with a welded rod.

This is often overcome with a welded brace by increasing the diameter at the welded section of the brace. This permits the brace to comply with the code but does not produce a brace rod free from welds.

Calculating Dished Heads

Q.—Can you send me an issue of your magazine or a reprint showing method of calculating on dished heads, spherical and parabolic? I am a reader of your magazine. H. V.

A.—Rules for calculating dished heads are given in the various boiler codes.

The rules and formulas as given in the A.S.M.E. Boiler Code are as follows:

(a) The thickness of a blank unstayed dished head with the pressure on the concave side, when it is the segment of a sphere, shall be calculated by the following formulae:

$$t = \frac{8.33 \times P \times L}{2 \times TS}$$

where:

t = thickness of plate, inches
P = maximum allowable working pressure, pounds per square inch
TS = tensile strength, pounds per square inch
L = radius to which head is dished, measured on the concave side of the head, inches.

Assuming the tank shown in Fig. 1 carries a working pressure of 250 pounds per square inch, and the tensile strength of the plate is 50,000 pounds per square inch, the required thickness of the head would be:

$$t = \frac{8.33 \times 250 \times 48}{2 \times 50{,}000} = \frac{93{,}960}{100{,}000}$$

$t = 0.9396$ inch, required thickness of the head

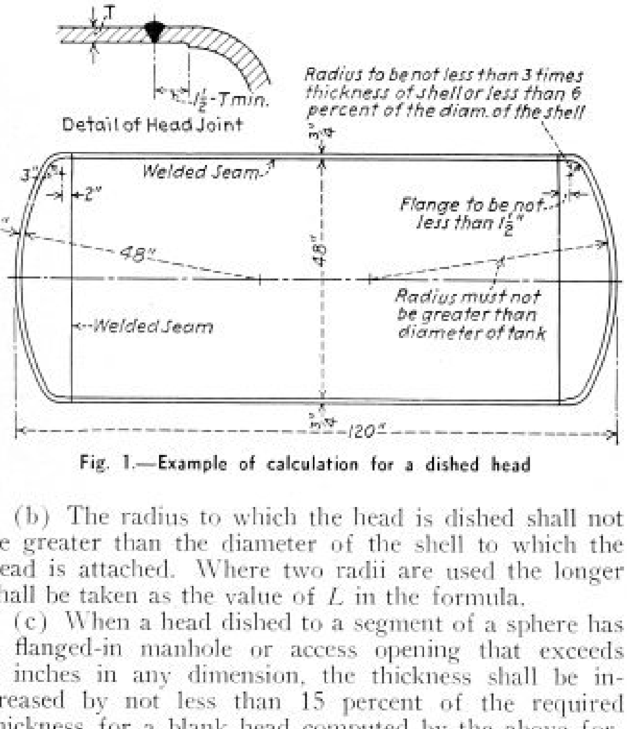


Fig. 1.—Example of calculation for a dished head

(b) The radius to which the head is dished shall not be greater than the diameter of the shell to which the head is attached. Where two radii are used the longer shall be taken as the value of L in the formula.

(c) When a head dished to a segment of a sphere has a flanged-in manhole or access opening that exceeds 6 inches in any dimension, the thickness shall be increased by not less than 15 percent of the required thickness for a blank head computed by the above formulae, but in no case less than ⅛ inch additional thickness over a blank head. Where such a dished head has a flanged opening supported by an attached flue, an increase in thickness over that for a blank head is not required. If more than one manhole is inserted in a head, the thickness of which is calculated by this rule, the minimum distance between the openings shall be not less than one-fourth of the outside diameter of the head.

(d) Where the radius L to which the head is dished is less than 80 percent of the diameter of the shell, the thickness of a head with a manhole opening shall be at least that found by making L equal to 80 percent of the diameter of the shell. Thus, thickness shall be the minimum thickness of a head with a manhole opening for any form of head.

(e) No head shall be of a lesser thickness than that required for a seamless shell of the same diameter.

(f) The diameter of the shell to be used in applying these rules shall be the inner diameter of the shell for a head fitted to the inside of the shell, and the outer diameter of the shell for a head fitted to the inside of the shell. Where a butt joint is used, the inner diameter of the thinnest portion of the shell shall be used in applying these rules.

(g) Unstayed dished heads with the pressure on the convex side shall have a maximum allowable working pressure equal to 60 percent of that for head of the same dimensions with the pressure on the concave side.

(h) When the flange of an unstayed dished head is machined to make a close and accurate fit into or on to the shell, the thickness shall not be reduced to less than 90 percent of that required for a blank head.

It will be noted in (a) that these rules apply to heads dished to the segment of a sphere, these rules, therefore, would apply to elliptical and spherical heads.

The various codes do not provide formulas for computing parabolic heads, and due to the varying shape of the parabolic, each case must of necessity become an individual problem and treated as such.

Trade Publications

General Utility Presses.—The subject of presses for forcing, bulldozing, dehydrating, recovering oils and liquids and general experimental and industrial work has been covered in a four-page illustrated bulletin, published by the Baldwin-Southwark Corporation, Philadelphia.

Hyspeed Hydraulic Presses.—A 20-page bulletin, illustrated with pictures and diagrammatic sketches, recently published by the Baldwin-Southwark Corporation, Philadelphia, describes Southwark Hyspeed presses, what they are, their mechanical construction, and their advantages over the mechanical types.

Pneumatic Wrench.—The Independent Pneumatic Tool Company, Chicago, manufacturer of pneumatic and electric tools, under the Thor trademark, has recently issued a circular illustrating and describing a pneumatically driven wrench known as Hamerench, for use in locomotive, structural steel, shipbuilding, automobile plant work, etc.

Blast-Cleaning Equipment.—The Pangborn Corporation, Hagerstown, Md., has prepared a new and complete quick-reference catalogue of condensed information on blast-cleaning and dust-collecting equipment. A full description of all the appliances, methods and procedure employed in blast cleaning is accompanied with illustrations of the various blast units built by the corporation.

Jigs and Fixtures.—As a guide to lowering tooling costs, the Lincoln Electric Company, Cleveland, has prepared a bulletin on the application of the shielded arc welding process to this industrial problem. The Lincoln Company, manufacturer of arc welded equipment, has pointed out the advantages of using this form of welding in the repair and manufacture of jigs and dies and has given specific illustrations where this process was used and an actual monetary saving effected.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—John M. Hall, Washington, D. C.
Assistant Chief Inspector—J. A. Shirley, Washington.
Assistant Chief Inspector—J. B. Brown, Washington.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Director—Joseph B. Weaver, Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 95 Liberty Street, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—D. S. Jacobus, New York.
Acting Secretary—M. Jurist, 29 W. 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—William H. Furman, Albany, N. Y.
Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.
Vice-Chairman—F. A. Page, San Francisco, Cal.
Statistician—L. C. Peal, Nashville, Tenn.

International Brotherhood of Boiler Makers, Welders, Iron Ship Builders and Helpers of America

International President—J. A. Franklin, Suite 522, Brotherhood Block, Kansas City, Kansas.

Assistant International President—J. N. Davis, Suite 522, Brotherhood Block, Kansas City, Kansas.

International Secretary-Treasurer—Chas. F. Scott, Suite 506, Brotherhood Block, Kansas City, Kansas.

Editor-Manager of Journal—L. A. Freeman, Suite 524, Brotherhood Block, Kansas City, Kansas.

International Vice-Presidents—Joseph Reed, 3753 S. E. Madison Street, Portland, Ore.; W. A. Calvin, Room 402, A. F. of L. Building, Washington, D. C.; Harry Nicholas, 6215 S. Benton Blvd., Kansas City, Mo.; W. E. Walter, 637 N. 25th Street, East St. Louis, Ill.; J. H. Gutridge, 2178 South 79th Street, W. Allis, Wis.; W. G. Pendergast, 1814 Eighth Avenue, Brooklyn, N. Y.; W. J. Coyle, 424 Third Avenue, Verdun, Montreal, Quebec, Can.; A. M. Milligan, 262 Trent Avenue, East Kildonan, Man., Can.; J. F. Schmitt, 28 S. Roys Street, Columbus, Ohio; William Williams, 1615 S. E. 27th Avenue, Portland, Ore.

Master Boiler Makers' Association

President: O. H. Kurlfinke, boiler engineer, Southern Pacific Company, 65 Market Street, San Francisco.

First Vice-President: Franklin T. Litz, foreman boiler maker, C. M. St. P. & P. R. R., Dubuque, Ia.

Second Vice-President: Ira J. Pool, field service representative, National Tube Company, 5610 Merville Avenue, Baltimore, Md.

Third Vice-President: L. E. Hart, foreman boiler maker, Atlantic Coast Line, Rocky Mount, N. C.

Fourth Vice-President: William N. Moore, general boiler foreman, Pere Marquette R. R., 625 College Avenue, S. E., Grand Rapids, Mich.

Fifth Vice-President: Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis (Big Four), 814 Big Four Building, Indianapolis, Ind.

Secretary: Albert F. Stiglmeier, general foreman boiler maker, New York Central, West Albany Shops, 29 Parkwood Street, Albany, New York.

Treasurer: William H. Laughridge, retired general boiler inspector, Hocking Valley R. R., 537 Linwood Avenue, Columbus, O.

Executive Board—Chairman: J. L. Callahan, general boiler inspector, Chicago Great Western, Oelwein, Ia.

American Boiler Manufacturers' Association

President: Starr H. Barnum, The Bigelow Company, New Haven, Conn.

Vice-President: W. F. Keenan, Jr., Foster Wheeler Corporation, New York.

Secretary-Treasurer: A. C. Baker, 709 Rockefeller Building, Cleveland, O.

Executive Committee (Three years); A. W. Strong, Jr., The Strong-Scott Manufacturing Company, Minneapolis, Minn. R. J. Bros, William Bros Boiler & Manufacturing Company, Minneapolis, Minn. E. R. Stone, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. (Two years): E. E. Knoblock, Union Iron Works, Erie, Pa. A. G. Weigel, Combustion Engineering Corporation, New York. J. F. Dillon, Jr., Struthers-Wells-Titusville Corporation, Warren, Pa. (One year): F. H. Daniels, Riley Stoker Corporation, Worcester, Mass. M. E. Finck, Murray Iron Works, Burlington, Ia. A. G. Pratt, Babcock & Wilcox Company, New York. (Ex-Officio): Starr H. Barnum, The Bigelow Company, New Haven, Conn. Walter F. Keenan, Jr., Foster Wheeler Corporation, New York.

Office of Industrial Recovery Committee,
15 Park Row, New York

Manager—James D. Andrew.
Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President — Merle J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

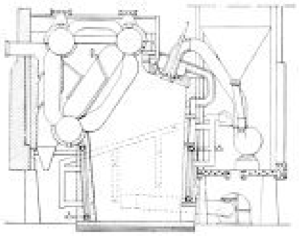
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,867,012. FURNACE AND METHOD OF OPERATING THE SAME. HENRY P. KIRCHNER, OF NIAGARA FALLS, NEW YORK, ASSIGNOR TO THE CARBORUNDUM COMPANY, OF NIAGARA FALLS, NEW YORK, A CORPORATION OF PENNSYLVANIA.

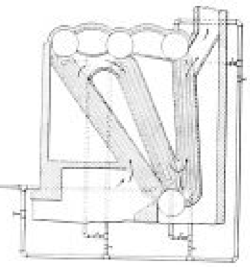
Claim.—In the method of operating a furnace having an air cooled silicon carbide wall, the steps which comprise circulating a current of air back of



the exposed face of the wall, cooling the air whereby the volume of air required is reduced, and selectively applying additional air to different portions of the wall where the temperature conditions are more severe. Three claims.

1,866,893. STEAM GENERATION. WALTER DOUGLAS LA MONT, OF NEW ROCHELLE, NEW YORK, ASSIGNOR TO LA MONT CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

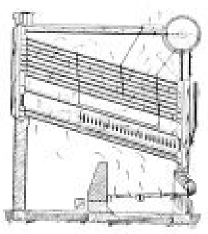
Claim.—The method of controlling the degree of superheating of steam which comprising passing steam through at least two superheaters situated



in different heat zones, combining the steam issuing from the different superheater, and varying the relative amounts of the steam passing through the different superheaters. Thirty claims.

1,880,253. SUPERHEATER BOILER. DAVID S. JACOBUS, OF JERSEY CITY, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

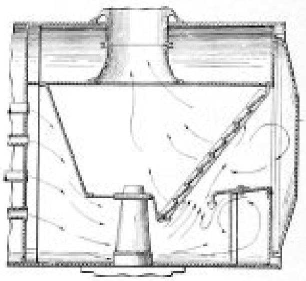
Claim.—In combination, a water-tube boiler having rows of horizontally inclined water tubes connected at either end by water chambers, a main gas



outlet, a superheater located between some of the rows of said tubes, a longitudinal baffle arranged to compel all of the gases to flow from the furnace toward the high ends of the water tubes and a set of baffles to direct some of the gases from the furnace back and forth across the tubes to the main gas outlet, some of the baffles of said set being also arranged to direct the remainder of the gases over the superheater in a direction longitudinal of the water tubes and then to the main gas outlet. Thirty-two claims.

1,887,922. SPARK ARRESTER. RICHARD M. CROSBY, OF TACOMA, WASHINGTON.

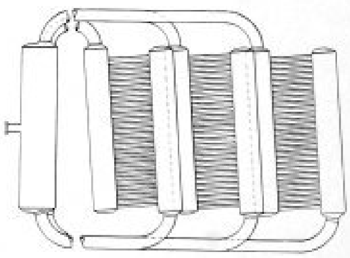
Claim.—In a locomotive boiler, a channel through which the products of combustion pass away from said boiler, a series of deflecting vanes extending in substantially a plane across said channel, said vanes lying



in parallel planes which are inclined to the plane of the series, the plane of the series being upwardly inclined toward one wall of said channel, each of said vanes having its lower edge spaced from the upper edge of the next adjacent vane to form apertures for the flow of the gases of combustion, and adjustable baffle means projecting into said channel and reducing the cross sectional area thereof at a point adjacent said series of vanes. Five claims.

1,864,587. MEANS FOR VAPORIZING LIQUIDS. HERBERT H. DOW, OF MIDLAND, MICHIGAN, ASSIGNOR TO THE DOW CHEMICAL COMPANY, OF MIDLAND, MICHIGAN, A CORPORATION OF MICHIGAN.

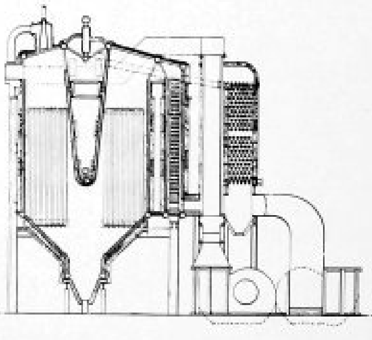
Claim.—In an apparatus for generating vapor, the combination of a plurality of sets of top and bottom drums, a plurality of vertical liquid-heating tubes connecting the top and bottom drum in each set, each such



set of top and bottom drums being located at slightly overlapping progressively higher levels, and a vaporizing chamber in common connected with and elevated above said sets of drums, the connections between said chamber and said drums including ducts between one end of the chamber and the corresponding end of the top drums and ducts between the other end of the chamber and the corresponding end of the bottom drums. *Two claims.*

1,888,975. STEAM GENERATING AND SUPERHEATING APPARATUS. JOHN E. BELL, OF BROOKLYN, NEW YORK; LOLA R. BELL, EXECUTRIX OF THE ESTATE OF SAID JOHN E. BELL, DECEASED, ASSIGNOR TO FOSTER WHEELER CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim.—In a boiler furnace heated by the combustion of powdered coal, the combination with a combustion chamber having roof portions oppositely



inclined from a peak, of a baffle depending from said roof beneath said peak to provide a U-shaped path of flow for the heating gases, steam and water separating means, radiant heat absorbing water containing elements lining the side walls of said chamber, and radiant heat absorbing elements lining the inclined roof portions of said chamber and connecting the first mentioned elements to said means. *Seventeen claims.*

Boiler Maker and Plate Fabricator

Boiler Orders Continue Uptrend

It is interesting to note that the uptrend in orders for steel boilers reported last month continued through July, according to information supplied by the Department of Commerce, Bureau of the Census. Orders for 1090 steel boilers were received during the month, double the number in that month a year ago, and exceeding the 1049 ordered in June, 1936. July orders aggregated 1,109,849 square feet of heating surface.

For the seven months now recorded a total of 5480 boilers of 5,771,466 square feet of heating surface have been ordered. This compares with 3507 in 1935 and 2312 in 1934, with corresponding increases in heating surface.

Success to the Master Boiler Makers

With the Master Boiler Makers' Association business meeting occurring at Chicago this month, it is rather timely to congratulate officers and members upon the rapid recovery in strength and prestige their association has made after the depression years when all activities were curtailed. The experiment conducted in 1935 of making the business meeting a general one was completely successful in spite of rather organized opposition from certain quarters.

With that success as a background there can be no question but that the meeting this year will bring out practically the full membership. Support from individual railroads is assured. Practically every important road in this country and Canada will be represented by one or more of the boiler department staff.

Whereas a year ago the status of the minor mechanical associations had not definitely been determined in their relationship with the Association of American Railroads, official action was taken some time ago that, since such organizations are not affiliated in any way with the A.A.R., it is a matter of discretion for the roads individually to decide whether or not they will have men in attendance. The result of this decision has been far reaching, for it has removed completely the last trace of opposition to the continuance of the minor associations, of which the Master Boiler Makers' Association is representative.

With the enthusiasm engendered by this official action of the organization of railroad executives, the officers have planned an outstanding meeting for this year as evidenced by the program published elsewhere in this issue. It is a business meeting solely—the social side of the conventions of the past being omitted. Nevertheless, the opportunity for members to fraternize for two or more days with men of kindred interests is probably the most beneficial phase of the entire gathering. For the younger members of the trade it is extremely broadening and to all it gives a fresh outlook on their work. The papers to be presented constitute only a starting point. The meeting will undoubtedly develop a wealth of practical information on methods and practices for the conduct of boiler work which does not appear on the program.

In order for the members to be able to crystallize their thoughts on the meeting shortly after it is over and also promptly to inform leading mechanical officials of the results of the meeting, the October issue of BOILER MAKER AND PLATE FABRICATOR will be devoted to a complete report of the proceedings.

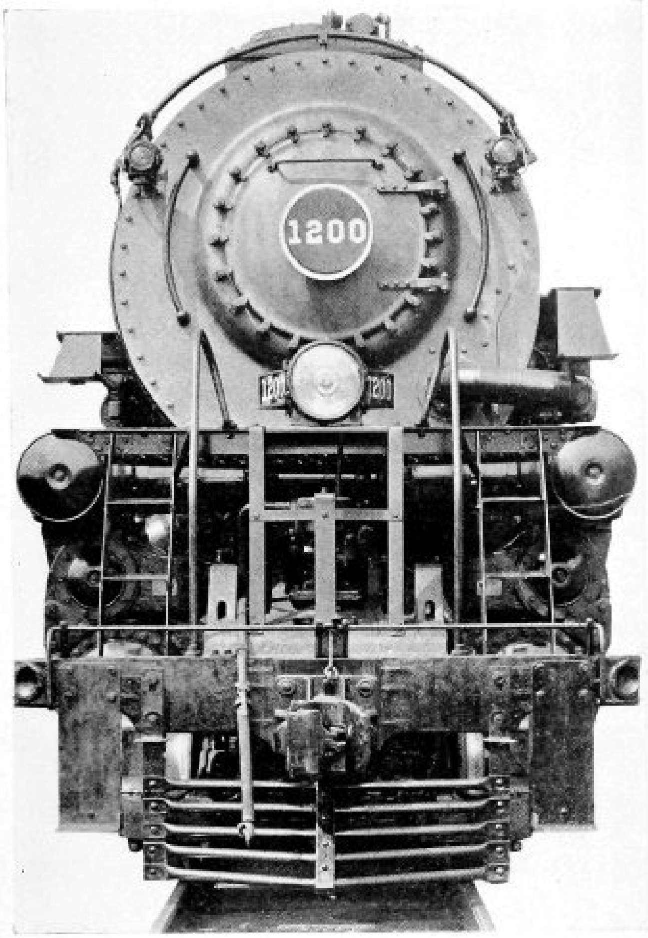
On the Subject of Welding

Not a day passes but some new application of the several fusion welding processes comes to light. The entire industry of heavy plate fabrication, the success of which is based upon ability to produce vessels and containers of all forms and descriptions to exact specifications, has been completely revolutionized during the past few years by this vastly improved tool. No industry has acquired greater flexibility in meeting widely diversified demands than this.

While individually the requirements for pressure vessels, tanks and miscellaneous plate work are greatly varied, the same principles apply rather generally throughout the entire field. The variations in technique are between materials.

It has been the object of BOILER MAKER AND PLATE FABRICATOR, since the inception of fusion welding by means of the oxy-acetylene and electric arc processes, to present all of the information which space permits on their application. Consistently since 1908 has this been done. During the past five years a greater proportion of editorial content than ever has been devoted to the subject of welding. Reports from our readers indicate that a vast amount of practical information has been obtained from our treatment of the subject—information that has been of actual commercial advantage to them.

The measure of successful treatment of a subject is in the response from readers. We will be interested at any and all times in learning from our readers whether or not they find we cover the subject of welding as comprehensively as they would wish. We would also like to receive suggestions as to additional phases of the subject in which they are most interested. This applies as well to the various other subjects treated in our pages.

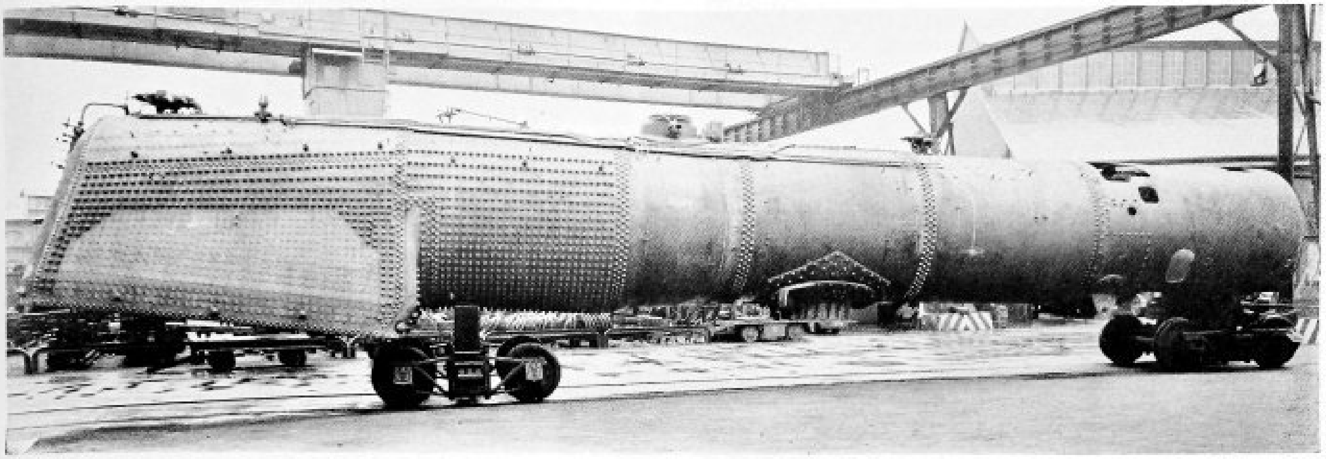


Boilers of unusual size feature

Norfolk & Western Locomotives

The Norfolk & Western, during May and June of this year, completed, at its Roanoke, Va., shops, two unusually large simple articulated Mallet locomotives which were designed for speeds of 60 to 65 miles per hour in time-freight service. Road tests which have been made with this new motive power indicate its ability to handle loads up to 4800 tons on a 0.5 percent grade at 25 miles per hour. On a comparatively level tangent this locomotive attained a speed of 64 miles per hour with a 7500-ton train. The boilers on these locomotives have

One of two new simple articulated Mallet locomotives built at the Roanoke shops of the Norfolk & Western



Largest boiler ever built for a Norfolk & Western locomotive

been specially designed for such service. The total weight of the engine and tender is 948,600 pounds and the total engine and tender wheel base is 108 feet 7¼ inches.

The boilers for the locomotives are designed for 300 pounds per square inch working pressure. They will be operated in service at 275 pounds per square inch. The water capacity of the boilers is unusually large, the boiler water capacity being 9835 gallons, which is accounted for as follows:

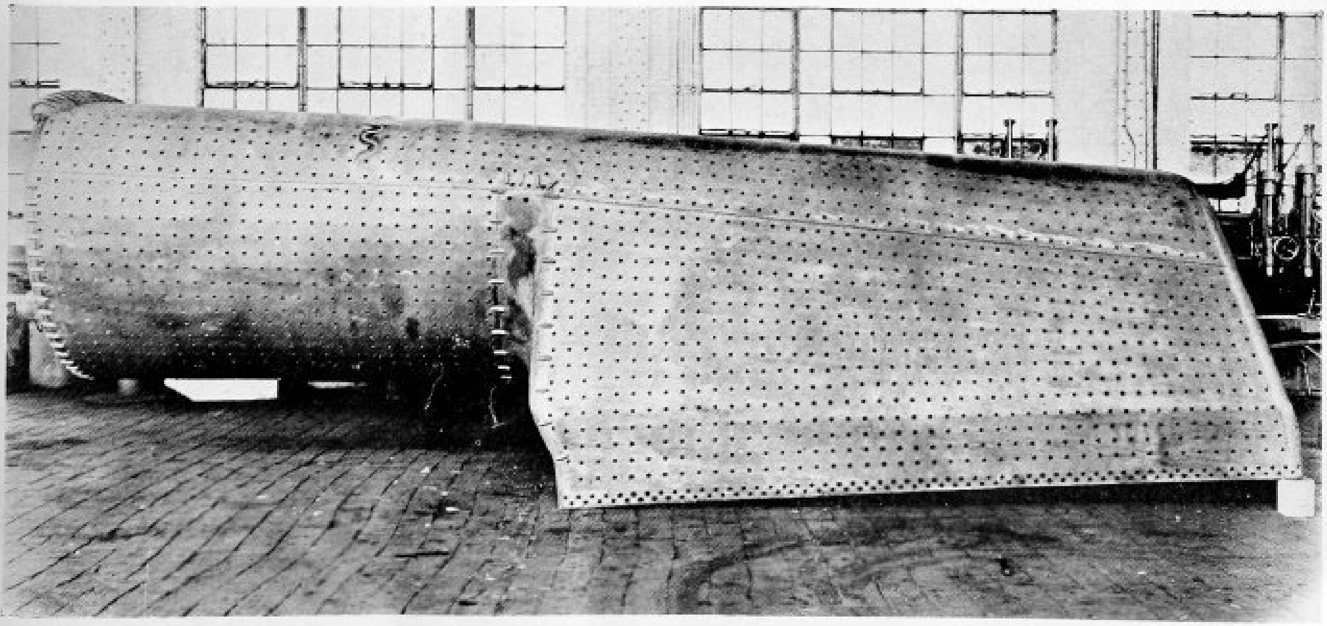
Empty to highest point of crown........	6365 gallons
Highest point crown sheet to first gage..	1205 gallons
First gage to second gage, 3³⁄₃₂ inch....	530 gallons
Second gage to third gage, 3³⁄₃₂ inch....	470 gallons
Third gage to full....................	1265 gallons
Total	9835 gallons

The overall length of the boiler is 60 feet 9³⁄₁₆ inches and has a total expansion of 1⁵⁄₁₆ inch from cold to 330 pounds test pressure.

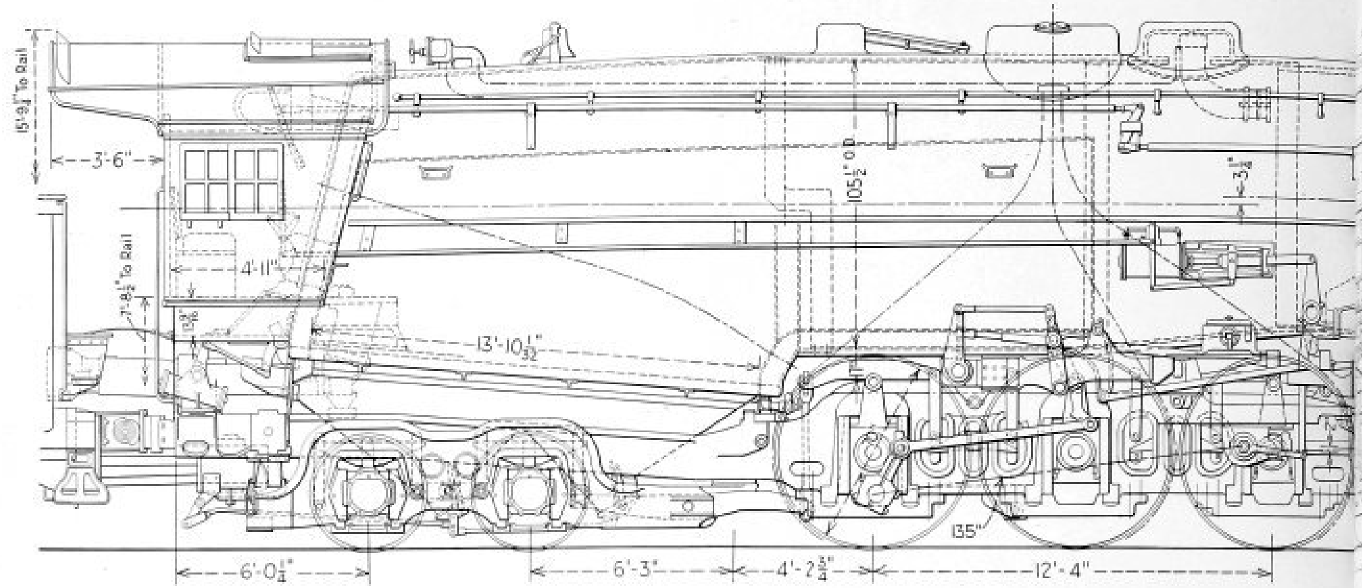
The boiler is of the conical type embodying a conventional stayed firebox and firetube shell. The barrel is rolled in four courses; the dome being located on the third course. The first shell course is fabricated from carbon steel 1⅛ inch in thickness and has an inside diameter of 91 inches. The second shell course is also made of carbon steel, 1⅛ inches in thickness, and has an inside diameter of 93¼ inches. The third shell course was made from nickel steel 1 inch in thickness; the course is tapered, being 95½ inches inside diameter at the front and 102 inches inside diameter at the back. The fourth shell course is made of nickel steel ¾ inch in thickness; the course is 104 inches inside diameter.

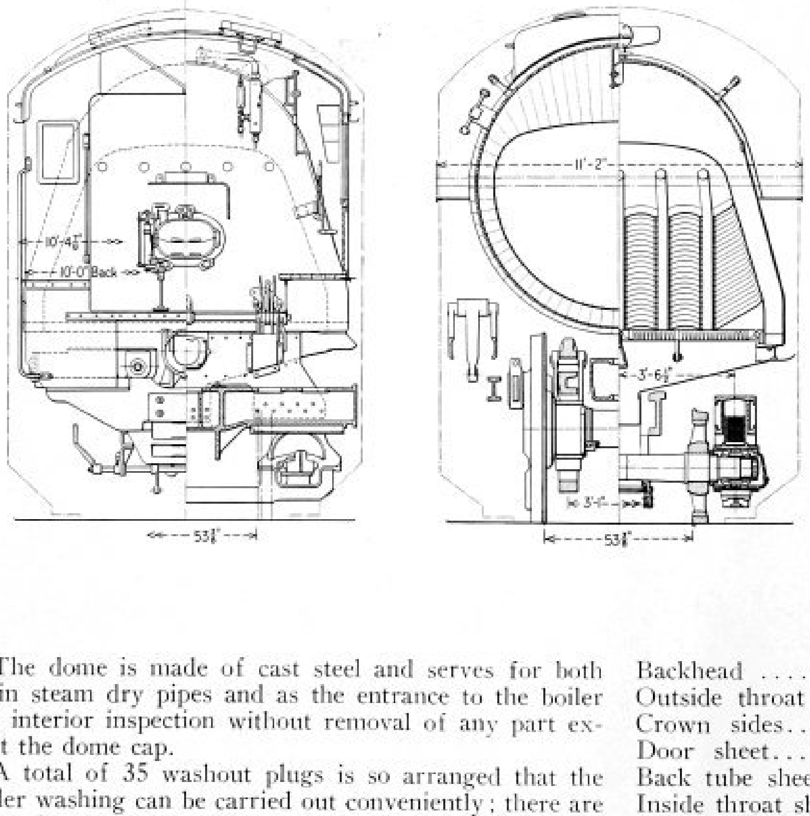
The front tube sheet is made from carbon steel, ¾ inch in thickness. The tube sheet is welded in, being supported by a 4-inch by ¾-inch ring which is riveted to the first course with sixty 1-inch rivets. The tube sheet is also supported in the tube area by twenty-two ¾-inch thick triangular braces welded to the tube sheet and the supporting ring. The front tube sheet is supported by thirty 1½-inch diameter welding steel braces having 1¼-inch diameter heat-treated welding steel pins and ¾-inch drop-forged lugs. The brace attachments for the front flue sheet including the dry pipe ring are of cast-steel.

The back head is supported by thirty-four 1½-inch diameter welding steel braces, having 1¼-inch diameter heat-treated welding steel pins and ¾-inch drop forged lugs. The brace attachments for the backhead are made of cast steel.



The firebox and combustion chamber were electrically welded throughout





The dome is made of cast steel and serves for both main steam dry pipes and as the entrance to the boiler for interior inspection without removal of any part except the dome cap.

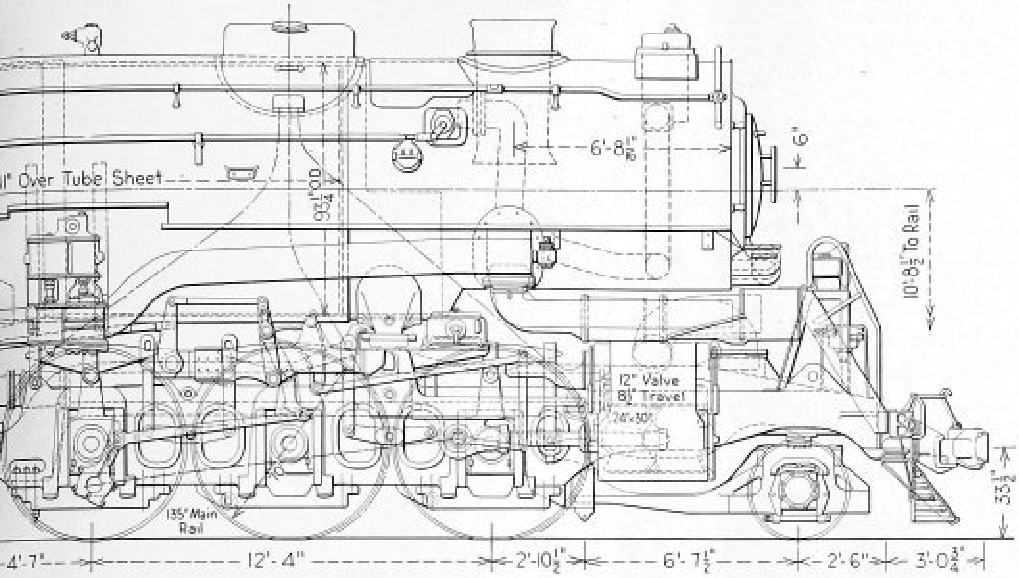
A total of 35 washout plugs is so arranged that the boiler washing can be carried out conveniently; there are 10 arch-tube plugs, all of the plugs being of a special design.

In fabricating the plates all holes were drilled undersize by $\frac{1}{16}$ inch diameter to allow for reaming. The holes were reamed to proper size and burrs removed from both sides of the sheet. All plates which were cut with an acetylene torch had not less than ⅛ inch allowance to be removed by chipping or planing in order to remove entirely the effect of burning. All tool marks on the face of the sheets which had been chipped or planed were removed by grinding.

The firebox roof sheet is fabricated from nickel steel ¾ inch thick, while the side sheets are made of carbon steel ½ inch thick. The other firebox sheets are made of carbon steel with thicknesses as follows:

Backhead	½ inch
Outside throat sheet	⅞ inch
Crown sides	⅜ inch
Door sheet	⅜ inch
Back tube sheet	½ inch
Inside throat sheet	½ inch
Combustion chamber	⅜ inch

The firebox is 24 feet ½ inch overall, including the combustion chamber. The length of the grate is 166 inches and width 106¼ inches, with a total grate area of 122.5 square feet. The combustion chamber is 9 feet 8 inches in length. The firebox is electrically welded throughout; the firebox crown and sides were made from three sheets. This was due to the fact that a single sheet of sufficient size was unobtainable. The layout and fabrication of this firebox was quite unusual. Originally it was planned to roll the entire unit from one sheet, but this was found to be impracticable, because of the great size. Details of the layout of a sheet of the general dimensions of this firebox are contained in an article which was published on page 14 of the Janu-



Erecting card and sections through the new Norfolk & Western Mallet locomotive

ary, 1936, issue. While the layout solution was somewhat different than that finally employed at the Norfolk & Western shops, readers can readily follow the general theory of a major problem of this character.

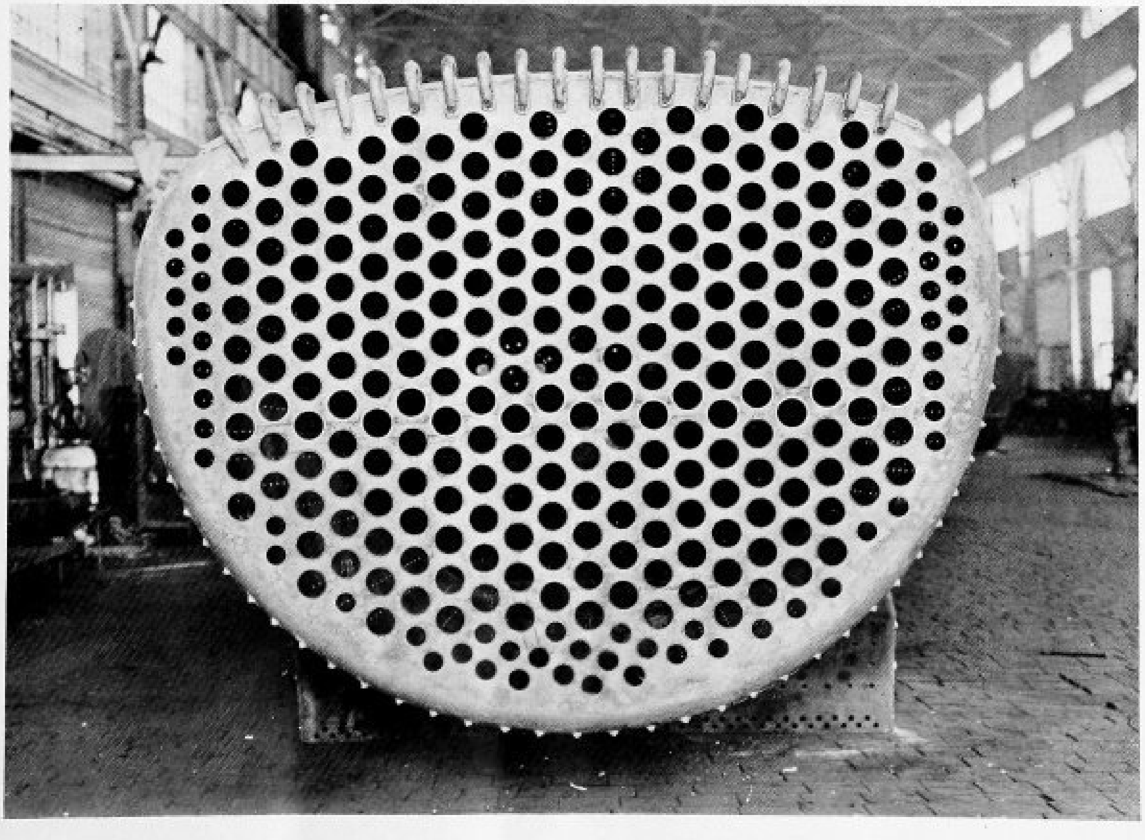
The back tube sheet was welded to the combustion chamber, being set in straight at the top and supported with reinforcing ribs.

The staybolt installation consisted of 1260 iron radial stays, 656 taper head solid iron water space stays, 745 taper head, hollow, iron water space stays and 2264 electrically welded iron flexible stays, making a total of 4925 staybolts throughout.

The boiler was equipped with a type E superheater. The tube installation consisted of 239 superheater flues —3½ inches outside diameter, No. 10 B. W. G. thick, 24 feet 1 inch long; 57 small fire tubes—2¼ inches outside diameter, No. 12 B. W. G. thick, 24 feet 1 inch long; 5 arch tubes 3½ inches outside diameter, No. 18 B. W. G. thick, 14 feet 3 inches long.

Upon completion the boiler was tested with a hydrostatic test of 375 pounds and then with a steam pressure test of 330 pounds per square inch.

These locomotives are of the single-expansion articulated type and have four cylinders, cast integral with the frames, 24 inches in diameter by 30 inches stroke. With 275 pounds boiler pressure and 70 inches driving wheels



Tube sheet electrically welded into combustion chamber they have a rated tractive force of 104,500 pounds. The cylinders are spaced 92 inches on centers and have 12-inch piston valves with a maximum travel of 8½ inches. The steam lap is 2 inches, the exhaust clearance is ¹⁄₁₆-inch, and the lead ¼-inch. The valves are operated by Baker valve gear which is controlled by an Alco type H reverse gear. The crossheads and guides are of the multiple-bearing type. The axles, crank pins and rods are of open-hearth carbon-steel forgings, normalized.

The rectangular water bottom tender has a cast-steel frame which also forms the water bottom. The water capacity is 22,000 gallons and the fuel capacity is 26 tons. The loaded weight of the tender is 378,600 pounds.

General Dimensions and Weights of the Norfolk & Western 2-6-6-4 Type Locomotives

Railroad	N. & W.
Builder	Railroad company
Date built	May and June, 1936
Road class	A
Road numbers	1200 and 1201
Type of locomotive	2-6-6-4
Service	Fast freight
Rated tractive force, engine 75 percent cut-off, pounds	104,500
Weights in working order, pounds:	
On drivers	430,100
On front truck	30,300
On trailing truck	109,600
Total engine	570,000
Tender	378,600
Wheel bases, feet and inches:	
Driving	35—5
Engine, total	60—4¾
Engine and tender total	108—7¼
Driving wheels, diameter outside tires, inches	70
Cylinders, number, diameter and stroke, inches	4—24 x 30
Valve gear, type	Baker
Valves, piston type, size, inches	12
Maximum travel, inches	8½
Boiler:	
Steam pressure, pounds	275
Diameter, first ring, inside, inches	91
Grate length, inches	166
Grate width, inches	106¼
Tubes, number and diameter, inches	57—2¼
Flues, number and diameter, inches	239—3½
Length over tube sheets, feet and inches	24—1
Fuel	Bituminous
Stoker	Type MB
Grate area, square feet	122
Heating surfaces, square feet:	
Firebox and combustion chamber	530
Arch tubes	57
Firebox, total	587
Tubes and flues	6063
Evaporative, total	6650
Superheating	2703
Combined evaporative and superheat	9353
Tender:	
Style	Rectangular
Water capacity, gallons	22,000
Fuel capacity, tons	26
Trucks	Six-wheel

Program of Master Boiler Makers' Business Meeting

The Master Boiler Makers' Association 1936 Business Meeting to be held in the Hotel Sherman, Chicago, on September 16 and 17, will follow the program given below, according to a recent release given out by the secretary of the association, Albert F. Stiglmeier.

Program

Registration of members and guests, Hotel Sherman, Chicago, Tuesday, September 15, at 6:30 to 7:30 p.m. Notice on hotel Bulletin Board.

Wednesday, September 16

Registration .... 7:30 to 9:30 a.m.

In order to participate in the discussions, badges will be required. None will be issued unless the members are registered. There will be no deviation from these rules.

Business session .... 10:00 a.m.
Meeting called to order .... 10:05 a.m.

Annual address, O. H. Kurlfinke, president of the association.

Routine Business

Annual report of the secretary, Albert F. Stiglmeier

Annual report of the treasurer, William H. Laughridge

Miscellaneous Business.

New Business

Appointments of Special Committees to serve during meeting

Memorials

Announcements.

Annual address, J. L. Callahan, chairman of the Executive Board.

Recess.

Afternoon Session

Registration .... 1:15 to 1:45 p.m.
Meeting called to order .... 2:00 p.m.
Committee Reports on Topical Subjects:

No. 1 "Committee on Law." Committee: Myron C. France, chairman, general boiler inspector, Chicago, St. Paul, Minneapolis & Omaha Railroad; Kearn E. Fogerty, general boiler inspector, Chicago, Burlington & Quincy Railroad; William N. Moore, general boiler foreman, Pere Marquette Railway; L. W. Steeves, boiler foreman, Chicago & Eastern Railroad.

No. 2 "Boiler and Tender Pitting and Corrosion." Committee: J. L. Callahan, special representative, National Aluminate Corporation (formerly general boiler inspector, Chicago Great Western); A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific Railroad; J. P. Powers, system general boiler foreman, Chicago & North Western Railroad.

No. 8 "Topics for 1937 Meeting." Committee: George B. Usherwood, supervisor of boilers, New York Central System (Lines East), chairman; W. H. Keiler, locomotive inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission; G. E. Burkholtz, general boiler inspector, St. Louis & San Francisco Railroad (Frisco); E. H. Gilley, general boiler foreman, Grand Trunk Railroad; P. W. Morgan, boiler foreman, Georgia & Florida Railroad.

No. 4 "Proper Brick Arch Setting in Locomotive Fireboxes." Committee: E. E. Owens, general boiler inspector, Union Pacific Railroad, chairman; B. G. King, assistant general boiler inspector, Northern Pacific Railroad; H. A. Bell, general boiler inspector, Chicago, Burlington & Quincy Railroad; C. F. Totterer, general boiler foreman, Alton Railroad.

Announcements.

Night session if necessary .... 7:00 p.m.
Recess until 9:00 a.m. Thursday, September 17.

Thursday, September 17

Registration .... 7:45 to 8:45 a.m.
Meeting called to order .... 9:00 a.m.
Unfinished Business .... 9:05 a.m.
Annual address: Albert F. Stiglmeier, secretary.

Address: John M. Hall, chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission

Committee Reports on Topical Subjects:

No. 3 "Autogenous Welding as Applied to Locomotive Boilers and Tenders." Committee: Albert F. Stiglmeier, boiler foreman, West Albany Locomotive Shop, New York Central System, chairman; John A. Doarnberger, master boiler maker, Norfolk & Western Railroad; S. Christopherson, supervisor of boiler inspection and maintenance, New York, New Haven & Hartford Railroad; H. H. Service, general boiler inspector, Atchison, Topeka & Santa Fe Railroad; G. E. Stevens, general boiler inspector, Boston & Maine Railroad.

No. 5 "Proper Thickness of Front Tube Sheets." Committee: Walter R. Hedeman, assistant mechanical engineer, Baltimore & Ohio Railroad, chairman; C. A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis Railroad (Big Four); E. C. Umlauf, supervisor of boilers, Erie Railroad; R. A. Pearson, general boiler inspector, Canadian Pacific Railway.

Announcements.

Recess.

AFTERNOON SESSION

Registration ....1:15 to 1:45 p.m.

Meeting called to order ....2:00 p.m.

Announcements.

Report on Committee Topical Subjects:

No. 6 "Proper Methods of Applying All Types of Staybolts to All Types of Boilers." Committee: Leonard C. Ruber, superintendent boiler department, Baldwin Locomotive Works, chairman; George M. Wilson, general boiler supervisor, American Locomotive Works; M. V. Milton, chief boiler inspector, Canadian National Railway; C. W. Buffington, general master boiler maker, Chesapeake & Ohio Railroad.

No. 7 "Improvements in Locomotive Front Ends." Committee: J. M. Stoner, supervisor of boilers, New York Central System (Lines West), chairman; E. M. Cooper, district boiler inspector, Baltimore & Ohio Railroad; H. E. May, general boiler and locomotive inspector, Illinois Central Railroad; G. E. Young, boiler foreman, Reading Railroad.

Election of Officers.

Report of the Chairman of Executive Board.

Good of the association.

Adjournment.

Work of the A.S.M.E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information on the application of the code is requested to communicate with the secretary of the committee, 29 West 39th St., New York.

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the council of The American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published.

Following are records of the interpretations of this committee formulated at the meeting of June 26, 1936, and approved by the council:

CASE No. 829 (*Special Rule*)

Inquiry: Where the provisions of the Power Boiler Code or interpretations thereof require that the fusion welding of pressure parts other than the drum joints comply with the requirements of Pars. P-101 to P-110, are sample test plates required for each such weld, or if not, what are the required qualification tests for the welding operators?

Reply: It is the opinion of the committee that it is not the intent of the code that individual test plates be made of the joints for work of the nature outlined in the inquiry, but that the welding operators must each have demonstrated their ability to make satisfactory welds by having previously made test plates which meet all the requirements of Case No. 751 and of Pars. P-101 to P-110, including stress relieving and radiographic examination of the weld. The thickness of the qualification test plates shall not be less than the approximate thickness of the plate or parts to be welded.

CASE No. 830 (*Special Rule*)

Inquiry: Is it permissible, under the A.S.M.E. Power Boiler Code, to attach an internal cylindrical furnace not exceeding 18 inches in diameter, to the flat heads of a boiler not exceeding 36 inches in diameter by 10 feet in length, by fusion welding after flaring the ends of the furnace; providing the distance between the edges of the tubes to the cylindrical furnace does not exceed 2 inches, the head outside the tube bank is stayed in accordance with the code requirements, the welding is equivalent to that required under the rules in Pars. P-101 to P-110 omitting radiographing, and the welding is stress relieved?

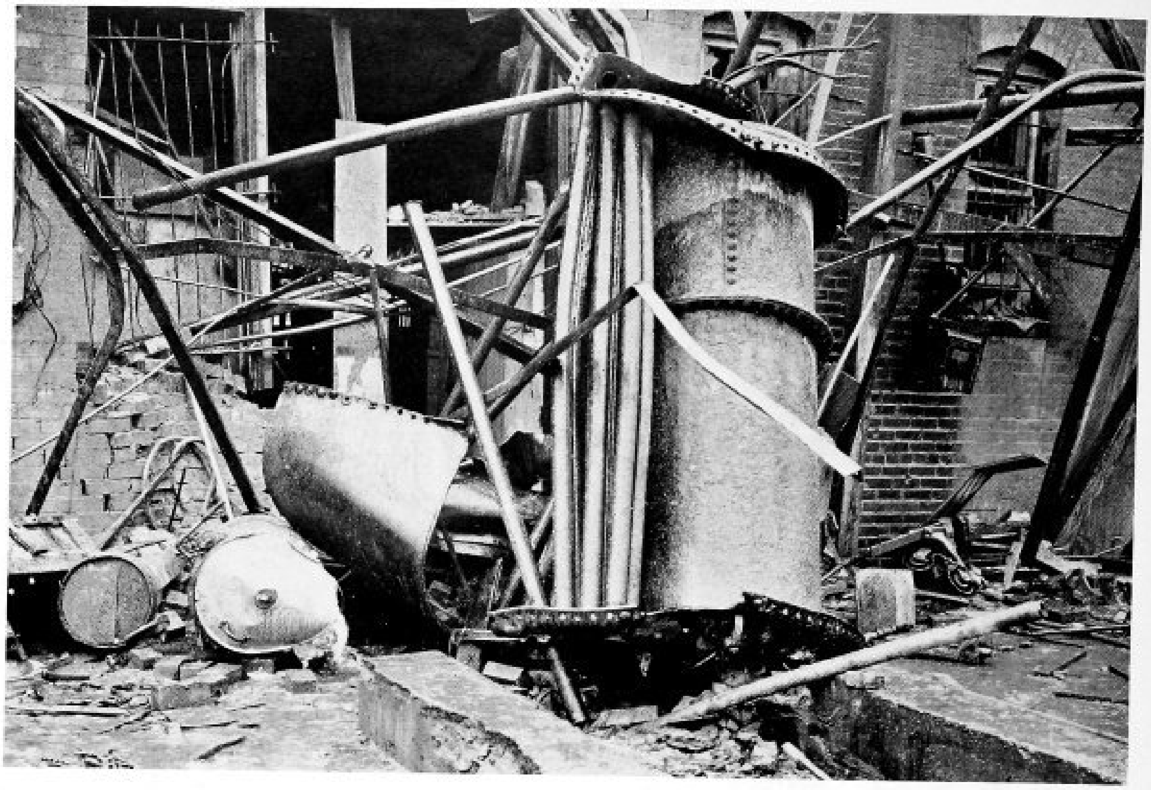
Reply: It is the opinion of the committee that the construction outlined in the inquiry, under the limitations stated, meets the intent of the code requirements.

A.S.M.E. to Meet at Niagara Falls

The Niagara Falls Meeting of the American Society of Mechanical Engineers, to be held September 16-19, will offer a combination that is unusually attractive. The meeting combines with the usual pleasure of visiting Niagara Falls, a special inspection trip to the General Electric Company plant at Schenectady and a two-day technical program at Niagara Falls, with an opportunity to meet many of the foreign engineers who will be visiting this country to attend the World Power Conference in Washington, D. C., September 7-12.

Wednesday, September 16, will be spent in the General Electric plant with the morning given over to plant inspection, luncheon in the plant and in the afternoon there will be given an unusual series of short talks on technical developments. The inspection of the factory will include visits to the House of Magic and special exhibits. Among the operations that can be seen are the manufacture of the hermetically sealed refrigerator, building of the large water wheel generators and motors for industrial application, inspection of large turbine generators in process of construction and assembly and a trip through the out-of-door mercury steam and electrical generator plant. A visit can also be made to the porcelain products department which will include inspection of a continuous kiln, one of the longest in the world.

The program at Niagara Falls will commence on Thursday at the headquarters at the Hotel Niagara. The Power and Hydraulic sessions have been arranged so as to co-ordinate with the post-convention tours of the World Power Conference. Five tours will be routed to Niagara Falls for the meeting. Several European engineers will be speakers in the technical sessions.



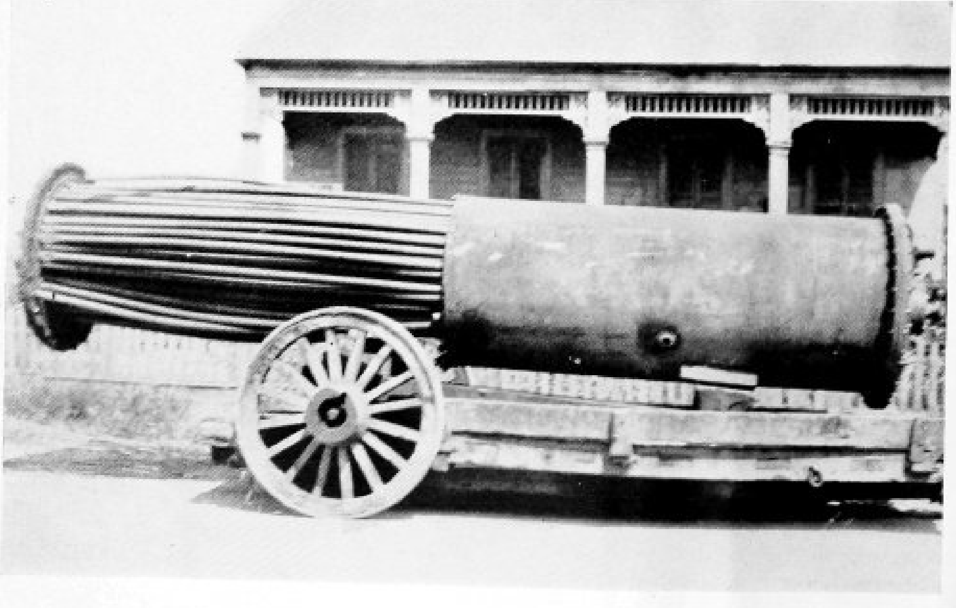
A check-up of welding in patch that failed might have prevented this accident

Safety in Fusion Welded Joints

By E. R. Fish*

Every purchaser of welded vessels (and many users of pressure vessels ranging from large watertube boilers to small air tanks are today such purchasers) should know of the efforts which have been and are being made in their behalf to secure welds which conform to the service requirements of the vessels they buy. In discussing

* Chief engineer, Boiler Division, Hartford Steam Boiler Inspection and Insurance Company. From an article in the July issue of *The Locomotive*.



Fusion welded ammonia condenser which failed; welding procedure and testing have advanced greatly since vessel was built the subject two points will be emphasized: (1) The steady improvement of welding procedure which gradually is overcoming shortcomings of much of the work; and (2) the fact that good work can be done and that properly welded pressure vessels are safe and can be depended upon to give long life and service.

Welding rods. It is a matter of common knowledge that up to within six or eight years ago most welding was done with bare wire, and without giving much, if any, thought to the various factors that contributed to the production of welds with the characteristics now regarded as essential. Although there were some who realized the shortcomings of the method and did much research work to determine how welding should be properly done, it was not until after the necessity of protecting the fluid metal from the action of the atmosphere was learned, that welds with the desired properties were attained. The use of special rods in connection with both gas and electric arc methods of welding is now practically universal for the welding of pressure vessels. Nevertheless, without proper precautions, improper work still may very easily result, even though the materials are entirely suitable to the purpose.

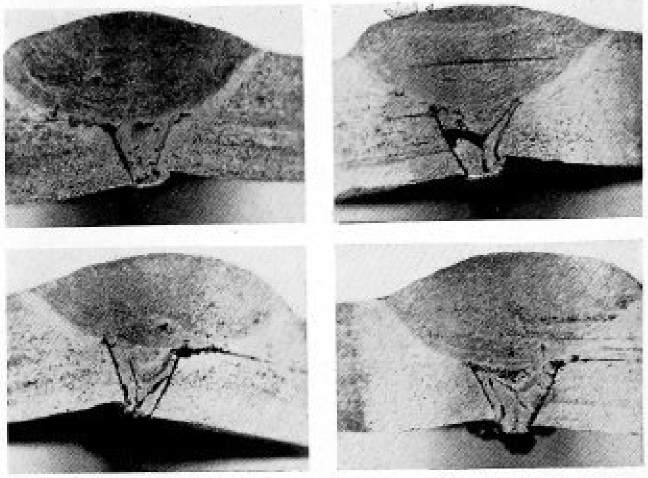
Welding procedure. It is absolutely necessary that each concern engaged in welding establish a definite technique or procedure by which its welding operators must be guided. After it has been demonstrated, through experimentation and research, that a certain procedure will result in strong, sound and ductile welds, that procedure must be adhered to.

Manufacturers generally have learned that, because a mechanic claims to be a welder and shows some proficiency in making smooth appearing welds, there is still no certainty that his work will meet modern standards. In general, these men are desirous of doing good work and take pride in doing so. However, because they have not had the advantage of facilities for making the kinds of investigations necessary to determine whether or not their work is what they hope it to be, they cannot be blamed for any failure to produce good work. It is primarily the function and duty of the manufacturer to determine what materials and technique must be used in making welded joints. On the other hand, it is the function of the welding operator to carry out the prescribed procedure in a skillful manner, once a procedure has been established.

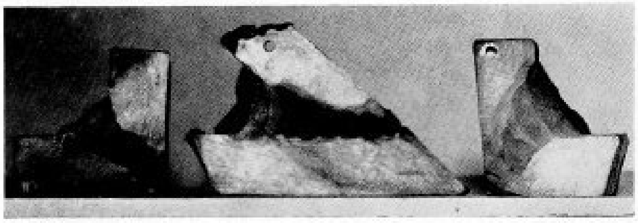
Unfortunately, it is absolutely impossible to determine, by external visual examination, what the character of a joint is. Externally it may look rough and unattractive and yet internally be perfect and have all the desirable physical qualities. And, *vice versa*, a weld that is attractive looking on the outside may be full of objectionable defects internally. For these reasons various effective tests have been devised.

Code requirements. The fundamental idea back of the code prescribing the characteristics of welded joints is that the resulting welds shall be reasonably perfect.

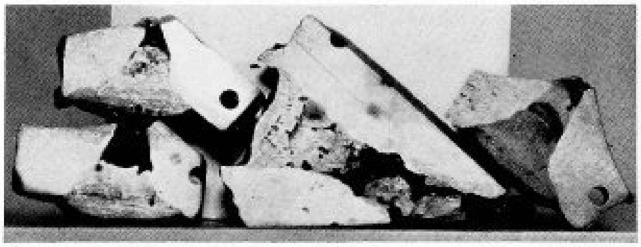
Among the provisions for the construction of power boilers and unfired pressure vessels used for the most hazardous service is that of making test plates for each object at the same time that the seams of the vessel are welded, so that the welding can properly be investigated as to its physical properties. The presumption is that, if these test plates are acceptable, the quality of the welded joints in the vessel itself may be accepted as meeting the requirements. In addition, X-raying is required for the purpose of showing, within the limitations of that process, the soundness of the weld metal. Radiographic determination does not in any way disclose the physical qualities of the weld metal. It does show the presence of gas pockets, slag inclusions, and lack of fusion, when this last is so located as to be picked out by the X-rays.



Samples of characteristic defects in welded seams



Good fusion in pipe joints



Examples of bad fusion

In the case of welded power boilers and U-68* pressure vessels, it is reasonable to assume, when they are completed in accordance with the code provisions, that there is little or no doubt that the joints of the structure can be depended upon. We need have little or no apprehension about the safety of such structures.

Many U-69* vessels are used for important and oftentimes quite hazardous service, but the provisions for assuring the proper fabrication of U-69 vessels are not nearly so searching as for U-68 vessels. No special test plates are required or is X-raying prescribed.

How may we, then, be reasonably certain that the welded joints of vessels in this category have the proper qualities? It should be demonstrated beyond reasonable doubt that welded vessels of this class have the kind of joints that they are presumed to have.

One requirement of the code is that all welders engaged in the fabrication of U-69 vessels must have demonstrated their ability to produce welds with the prescribed physical characteristics before these workmen are permitted to fabricate vessels which are to bear the code

* U-68 pressure vessels may be used for any purpose. U-69 vessels are limited to 400 pounds per square inch pressure and 300 degrees F. temperature for liquids and 700 degrees F. for gases. U-70 vessels are limited to 200 pounds per square inch pressure and 250 degrees F. temperature. See A.S.M.E. Unfired Pressure Vessel Construction Code.

stamping. It is on the basis of these demonstration tests alone that the character of the welds, including the soundness thereof, is judged. They are depended on to indicate the integrity of the welds. The foregoing remarks with respect to U-69 vessels are applicable also to U-70 vessels. The question now arises as to what extent the dependence on the ability of the welder is justified.

Insurance company findings. Investigations by "Hartford Steam Boiler" of welded vessels constructed anywhere from five to twenty years ago have disclosed positively that there were as many questionable welds as good ones produced, if, indeed, there were not many more poor ones. These questionable welds were made not because of any negligence on the part of the fabricator, but rather because at the time there were no established requirements for making welds.

The disclosures of these investigations have made the company's engineers feel that, without knowing with relative certainty the character of the welded joints of these vessels that they are asked to insure, they should hesitate to accept the risks.

Furthermore, in investigations of vessels, presumably built in accordance with the present code requirements, there have been found welds that did not have the prescribed characteristics, the welded seams oftentimes lacking in penetration and having unfused areas.

How then, could the exact condition of the welded joints, either old or new, be determined in order to be assured that they were in a reasonably safe condition? Apprehension as to their character prompted considerable thought on this point, with the result that several ideas were suggested. Both old and new structures were and are involved in the plan now used.

It must be conceded that only by making an actual examination of the seam by a destructive test, can its exact character throughout be determined. Manifestly this is entirely impracticable. However, it is reasonable that a sample, taken from one section of the weld, may be presumed to be fairly representative of the whole weld and it was on this idea that the development of an investigatory method proceeded. The first proposal was to cut an opening across the welded seam about the size and shape of a handhole and then to close this by means of a plate, larger than the hole, placed on the inside and fillet welded for tightness. The idea was that the section of plate removed could be subjected to such tests as would show the soundness of the weld. However, very little progress was made with this particular idea and it was soon abandoned.

The next step was to drill a hole large enough to cover the entire width of the weld, and smooth and etch the walls of the hole so as to bring out any imperfecfections there might be. This was not very satisfactory because of the difficulty of properly preparing and etching the metal and of making a proper examination. However, some few seams were examined in this way with fairly satisfactory results.

In recent months the practice has been to trepan a small plug or button from across the weld. This plug or button, say an inch or an inch and a quarter in diameter is taken to a shop or laboratory, sawed into sections, the edges properly prepared, and etched. The etching is done by immersing the specimen in boiling 50-50 hydrochloric acid solution. This brings out, in a most illuminating fashion, the presence of slag inclusions, gas pockets, and lack of fusion. There is no doubt about the character of the weld at that point. When such plugs are studied by those familiar with the characteristics of welds, the story of the soundness or the defectiveness of the weld is apparent.

The preferred method of closing a trepanned hole is by means of a threaded plug. The tapping may be either straight or tapered. In either case tightness can be secured by a light bead of seal welding on the outside. With a straight thread this is absolutely necessary. Different kinds of welded-in plugs have been suggested, but the threaded type now seems best. By finishing off the outside the location of the plug will not be noticeable.

Numerous welds in non-code vessels have been examined by the trepanning method and of them a surprisingly large number has been found to be seriously defective. In only a few cases were the welds sound. In the great majority of cases defects of some extent were noted and in many cases the defects were so serious that the vessel was considered unsafe to operate.

The great advantage of the trepanned plug is that the person or persons in responsible charge of the vessels can be shown exactly what the condition is at the point from which the plug is removed. There is no theorizing, guesswork, or opinion involved. There is the actual, incontrovertible evidence of the weld itself. On the basis of such an examination of a weld at specific points, a very good opinion can be formed as to the general soundness of the seam. Furthermore, it has taken examinations of this sort to prove to many manufacturers, who sincerely thought their work was above criticism, that they were not doing the kind of welding they thought they were. There have been many instances of this.

How cracks develop when fusion is not complete. If it is necessary to have sound plates, free from laminations and other defects, is it not just as important that the weld metal that joins together the edges of the plate should be as sound as the plate itself?

That, for practical purposes, this is not possible is recognized by the provisions for joint efficiencies in the code. It is an admission that 100 percent perfect welds are not to be expected from a practical point of view. Some defects will occur, but there is a definite limit beyond which they should not be permitted.

In practically all types of pressure vessels minute variations of shape are continually taking place because of pressure and temperature changes. These changes set up stresses of unknown magnitude and distribution which are very likely to be highly concentrated at weak points. If there is a lack of fusion, the surfaces are close together but are not bonded together. The resultant minute parting makes an ideal condition for a real crack to start through the weld, beginning in the metal where the parting ends. Evidences have been found that such cracking does take place. Also in the process of cooling and shrinking there is a considerable tendency for the weld metal to crack so that such defects as lack of fusion form a starting point for a crack. These points of possible future failures should be discovered and rectified before the vessel leaves the shop.

The testing of welds in the manufacturer's shop. In addition to the use of the trepanning method for determining the quality of welded seams in vessels already in service, it might, very logically and appropriately, be made a feature of shop inspections. In other words, after a U-69 or U-70 vessel has been completed in the shop, why should not the final item of inspection be the trepanning of a plug from each unit of a predetermined number of feet of welded joint?

The adoption of this plan would greatly stimulate both the manfacturer and the welding operator to do only the best of work all the time. Not knowing from what points the plugs would be taken, it would be necessary that all the welding be of uniformly gool quality, if the penalties attached to the discovery of imperfect workmanship were to be avoided. The psychological effect thus created would be a most important incentive to good work and would do more to maintain a high standard of workmanship than any other one item.

In the past, due to the lack of confidence in welding, there has been established a rule that no opening should be made in a weld. However, the added security in a weld which has been tested by having plugs trepanned from it will more than offset any weakening effect caused by the openings.

As an alternative to the trepanning method, it has been suggested that a thin slab be sawed out across the weld. This method has been used to a limited extent, but special tools must be devised for its convenient use. As only a narrow slot is made in the girthwise direction it can easily be closed by welding. The examination of the removed slab would be exactly the same as for the trepanned plug, and there would be exactly the same beneficial results.

Complicated fittings and piping. The construction by fusion welding of complicated pipe fittings not otherwise possible, as well as the welding of pipe lines of all sizes and for all pressures, is rapidly becoming more general. Much of this work has to be done in the field and under circumstances requiring special ability on the part of the welding operators to do work in all positions. Furthermore, although welding can be done only from the outside of the pipe, it is important that full penetration be obtained throughout the thickness of the pipe wall and without the formation of "icicles" inside the pipe.

Qualification of each welder is of great importance in this work, because here again the dependence of acceptably sound welding rests on the skill of the men.

There has been less effort expended in this field, to find out how to produce good welded pipe joints, than in the case of pressure vessel construction, and much imperfect work has been produced. To check the kind of work done many specifications now require that an occasional joint be removed. Such sections are cut up and tested by bending, etching, etc. One such examination will give a good indication of the character of the joints generally, but a specimen of each man's work is necessary.

As there are many stresses of unknown magnitude and distribution set up in piping, in addition to those due to internal pressure it is necessary that practically perfect welds be produced, and that the work be frequently checked. Knowing that any joint may be removed for testing, the men are inspired to do their best work on every joint. Removing a joint, of course, necessitates making two joints in replacing the section, but that is relatively of little importance when the advantage of knowing what kind of work is being done is considered.

The trepanning or slotting method may often also be used either alone or in addition to the removal of joints. By combining the methods, some examination of every important joint in the pipe line is possible. In the case of welded fittings of the larger sizes, samples may be taken out at certain points.

It is only by some such methods as have been outlined, of actually investigating the character of welded joints of all kinds, that their soundness and ability to withstand continued service indefinitely and safely can be determined. It is to be hoped that the ideas set forth will be fruitful of results beneficial to all concerned.

General Refractories Vice-President Moves

J. T. Anthony, vice-president of the General Refractories Company, moved his headquarters on September 1, from New York to the general offices of the company in the Real Estate Trust building, Philadelphia, Pa.

Welding high-pressure steam piping at River Rouge power plant

All-Welded Piping Used in Ford Power Plant

When the Ford Motor Company decided more than a year ago that the Ford Rouge plant power house should operate at the highest steam temperature ever used in a large industrial power plant, a real problem arose and was solved by the application of modern industrial practice. The steam from the new boiler was to be superheated to 900 degrees F. which is high enough to make pipes glow cherry red in the dark. The pressure was to be more than 1200 pounds per square inch, the highest pressure ever used in a large industrial plant and the River Rouge plant is the world's largest. That meant a better way of connecting the pipes had to be found than the old-fashioned method of using flanged and bolted or threaded joints.

Because welded pipe joints possess many advantages, it was decided to undertake the first all-welded high temperature steam piping installation in history. The huge staff of welders at the Rouge plant was combed for months until 23 men passed the rigid tests and qualified for the power house welding job. A "stress relieving" machine, to bake the stresses out of the freshly welded joints, was designed and built. Now the new $5,000,000 power installation is in operation. Out of the 1600 welded joints not one has shown a tendency to develop a leak.

Distributors Appointed by Republic

Conner Manufacturing Company, Louisville, Ky., and Charles Millar & Son Company, Utica, N. Y., have been appointed distributors of Enduro stainless steel for the Republic Steel Corporation, Cleveland, O. Taylor-Parker Company, Inc., Norfolk, Va., has been named distributor of Republic tubular products.

Redrafting locomotives by modifying

Master Mechanic's Front End

At the meeting of the Mechanical Division of the Association of American Railroads, in Chicago, June 25 and 26, a subcommittee of the Committee on Locomotive Construction presented a proposed new standard method of drafting steam locomotives, based on a proper proportioning to each other of the gas areas over the brick arch and throughout the smokebox. An abstract of the report follows:

The subcommittee report was signed by D. S. Ellis (chairman), mechanical assistant to the vice-president, Chesapeake & Ohio Railroad, and A. H. Fetters, general mechanical engineer, Union Pacific.

Employing the same general arrangement of the smokebox details and adhering basically to the design known as the "Master Mechanic's" front end, as described in the 1906 Proceedings of the American Railway Master Mechanics Association, the proposed method has been developed from an analysis of data secured from standing and road test results while redrafting various classes of bituminous coal burning locomotives of conventional design in a wide variety of service and using all the common kinds and mixtures of bituminous coal.

The details of the smokebox and arrangement of the "Master Mechanic's" front end design consist of an exhaust stand with round-bore exhaust nozzle, smokestack and stack extension bolted together, a diaphragm plate or vertical back deflecting plate, a table plate supported by the exhaust stand and attached to the diaphragm plate and sides of the smokebox, an adjustable draft sheet attached to the table plate, and smokebox netting attached to the table plate and the interior of the smokebox and usually applied in a sloping position.

From a study of the gas areas of properly drafted locomotives and observations made while redrafting, it was discovered that there is a definite and necessary relation of these areas to each other and that this relation is practically identical on all the locomotives redrafted. It has been considered logical therefore, to use one of these areas, namely, the minimum net gas area through the tubes and flues, as an index to which the other gas areas, including the minimum area of the smokestack, should be compared and proportioned.

Comparison of stack diameters determined by the method recommended with the diameters of existing stacks or stack diameters determined by other methods in general use discloses in a majority of cases that larger stacks may be used. The use of larger stacks permits the use of larger exhaust nozzles with subsequent reduction in back pressure. Reduction in back pressure, when accompanied by satisfactory steaming qualities and fire conditions, results in a saving of fuel.

While this discussion is devoted particularly to redrafting existing locomotives, the method outlined is equally applicable to new locomotives, and the designs for brick arch and smokebox details of a new locomotive may be developed in accordance with the plan as soon as the minimum net gas area through the tubes and flues is known.

As the principles and method of drafting recommended have been gathered from tests made with locomotives equipped with grates having 20 to 30 percent effective air opening, it is possible that minor changes in some proportions may be necessary to obtain satisfactory results when drafting locomotives having grates with net air opening not within these limits. The recommended practice will, however, serve as a guide and such changes in proportions as may be found necessary as a result of tests should then be made a part of the method.

Fig. 1 illustrates the recommended arrangement of smokebox details, with recommended gas areas and other pertinent data. Fig. 2 illustrates the recommended brick arch design, together with recommended net area of the opening between the back end of the arch and the crown sheet.

When preparing to redraft a locomotive or make changes to improve steaming qualities, the first step is

GAS AREAS—PERCENT OF MINIMUM NET AREA THRU TUBES AND FLUES

AREA	PERCENT OF MINIMUM NET GAS AREA THRU TUBES AND FLUES	
	PREFERRED	PERMISSIBLE LIMITS
A	25	23 TO 27
B	130	110 TO 140
C	85	80 TO 95
D	75	65 TO 80
E	55	55 TO 110

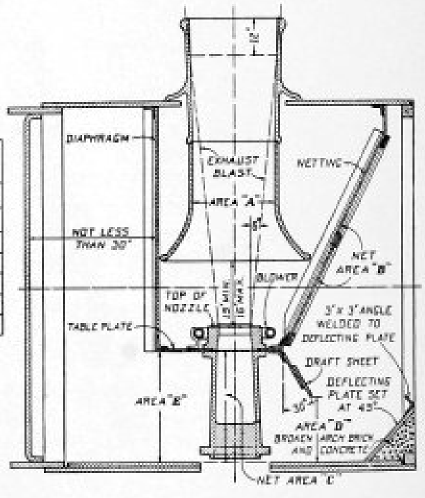


Fig. 1.—Smokebox arrangement

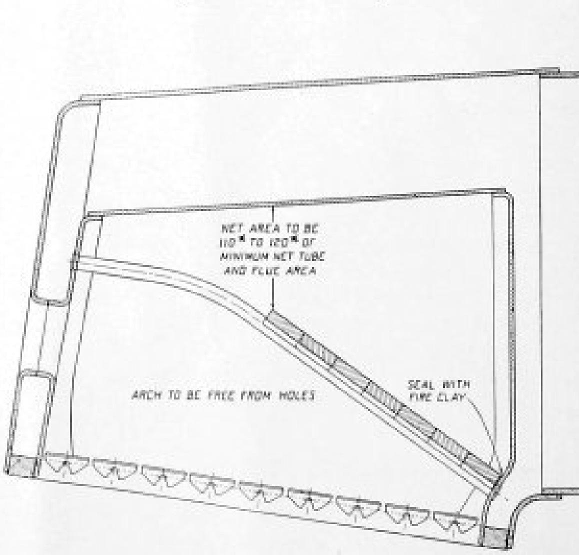


Fig. 2.—Brick arch arrangement

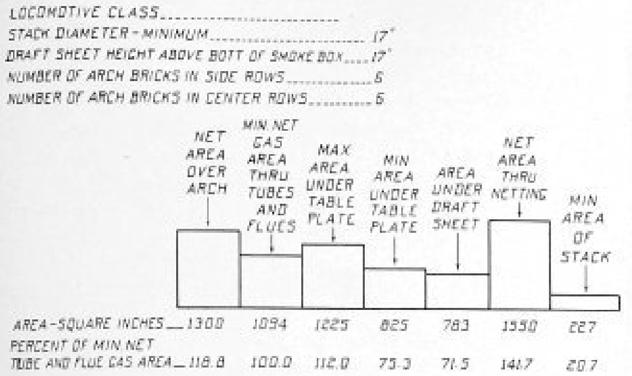


Fig. 3.—Actual gas areas, U.S.R.A. Mikado locomotive

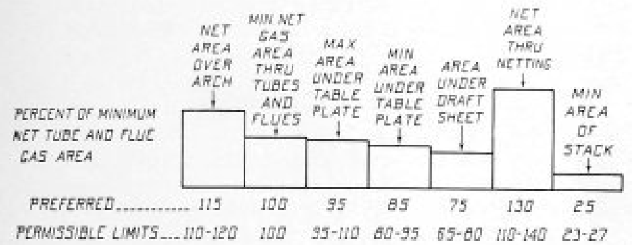


Fig. 4.—Recommended gas areas

to calculate and tabulate actual gas areas. These may be calculated in square inches and are as follows:

1—Net area between top of brick arch and crownsheet at rear end of arch.
2—Minimum net gas area through tubes and flues.
3—Maximum area under table plate.
4—Minimum net area under table plate (opposite exhaust stand and steam pipes).
5—Area under draft sheet.
6—Net area through smokebox netting.
7—Area of smokestack at minimum diameter.

In tabulating the gas areas a graphical chart such as Fig. 3 is recommended. The minimum net gas area through the tubes and flues is used as the base for plotting the other areas and is rated at 100 percent. A percentage tabulation of the other areas is also given. Each chart should carry such important data as locomotive classification, size of stack, etc. A typical group of actual gas areas for a U. S. R. A. Mikado type locotive is shown in Fig. 3.

Recommended gas areas are illustrated in Fig. 4 as a percentage of the minimum net gas area through the tubes and flues. The areas shown form the basis of the proposed new method of drafting and have been successfully employed in redrafting several hundred locomotives. Many new locomotives drafted to these proportions have been placed in service and operated under varying conditions without any change in smokebox details.

In Fig. 4 there is a gradual stepping down in the preferred areas from the area over the arch to the area under the draft sheet. While this condition is ideal it will be found necessary in some cases to have the maximum area under the table plate somewhat in excess of the minimum net gas area through the tubes and flues in order that the minimum area under the table plate shall not be less than under the draft sheet. Where this condition exists it has been found that the draft sheet loses most of its value as a regulator of the drafts.

Application of the recommended proportions to the locomotive for which the actual gas areas are tabulated in Fig. 3 permitted an increase in stack diameter from 17 inches to 20 inches. This, in turn, made it possible to increase the exhaust-nozzle diameter from 7 inches to 8 inches with entirely satisfactory results and with a substantial saving in fuel.

Space Between Front Flue Sheet and Diaphragm Plate.—Not infrequently on some older locomotives it is found that the diaphragm plate is less than 30 inches ahead of the front flue sheet. This condition is usually responsible for excessive heat at the firedoor. In exaggerated cases the flames in the firebox have a tendency to roll and not move freely over the brick arch. In all cases where the diaphragm plate is less than 30 inches ahead of the front flue sheet it is recommended that the diaphragm be sloped forward at the bottom from a point in line with the bottom of the superheater header. The

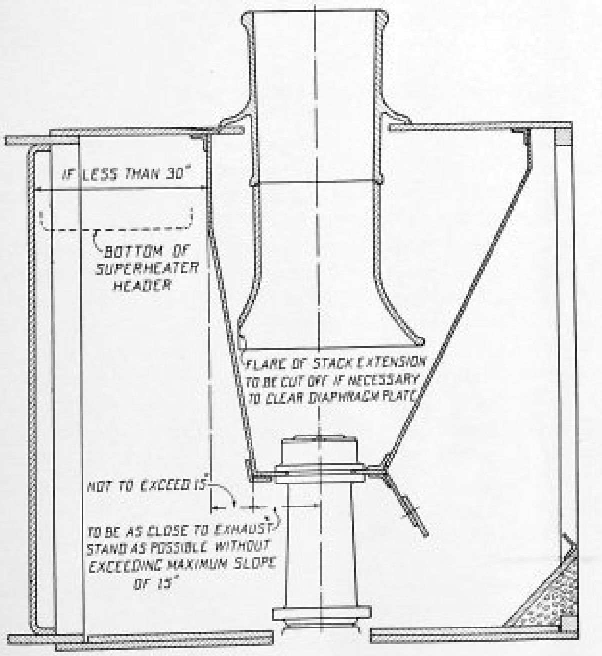


Fig. 5.—Sloped diaphragm plate should be used when diaphragm is less than 30 inches ahead of flue sheet

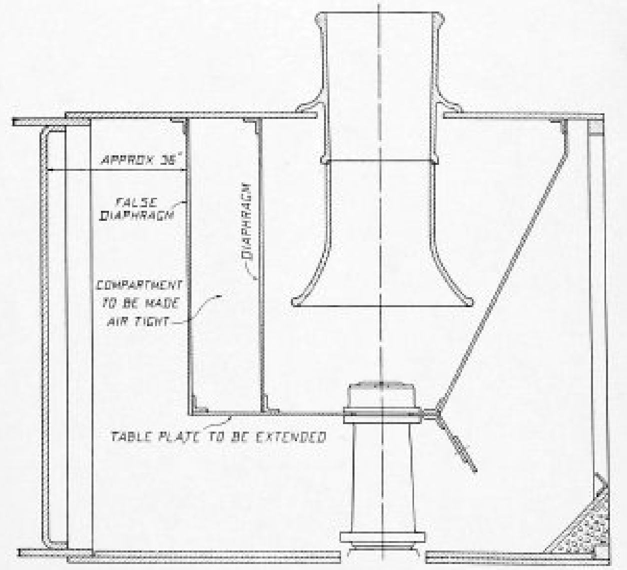


Fig. 6.—Application of false diaphragm to reduce excessive smokebox volume behind diaphragm

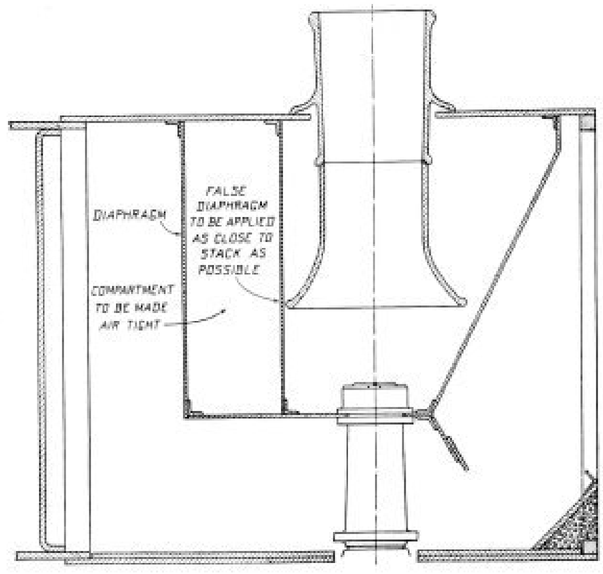


Fig. 7.—Application of false diaphragm to reduce excessive smokebox volume between stack and diaphragm

total amount of slope will usually be determined by the distance between the exhaust stand and the diaphragm and should not exceed 15 inches. Where the flare of the smokestack interferes with obtaining the desired slope in the diaphragm a small portion may be cut off the flare without harmful effects. The portion of table plate projecting backward beyond the new location of the diaphragm plate should be cut off as shown in Fig. 5. On some modern locomotives a reverse condition is encountered and the diaphragm plate is an excessive distance from the front flue sheet. With smaller locomotives this may be responsible for difficulty in obtaining sufficient draft. Where such an effect is recognized it has been found helpful to install an additional diaphragm plate in back of the existing plate and approximately 36 inches ahead of the front flue sheet. The table plate should be extended over to the extra diaphragm and the compartment thus formed made air tight, Fig. 6. The superheater damper is located in the passage between the front flue sheet and diaphragm plate. Some roads have removed all superheater dampers while others have retained them. It is not intended to approve or criticize either practice. However, it has been noted that drafting of locomotives by the method described has been more successful when dampers have been removed. All accompanying diagrams have been prepared on that basis.

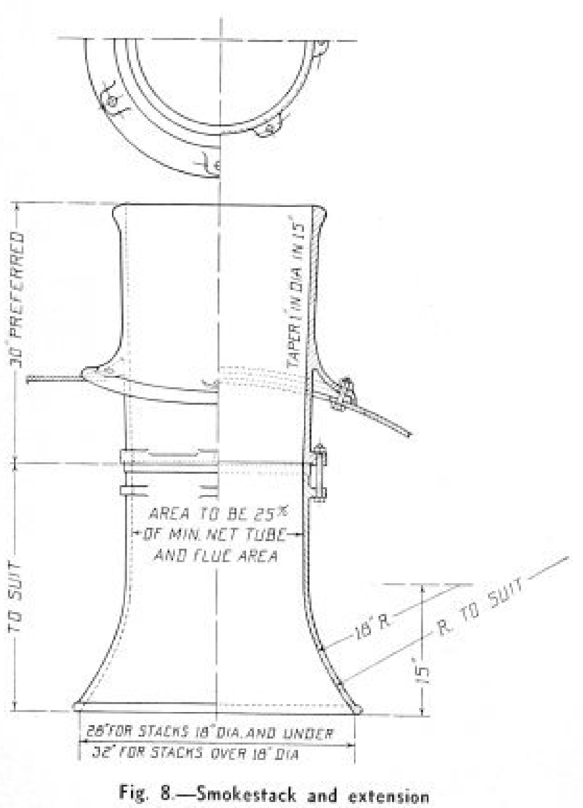


Fig. 8.—Smokestack and extension

Space Between Diaphragm Plate and Back of Stack.—The space in back of the stack may also be excessive, although this is not as likely to be responsible for poor steaming as excessive space behind the diaphragm. On smaller power, however, if the diaphragm is more than 12 inches behind the back side of the stack some improvement may be noted if an additional diaphragm plate is applied as close to the stack as possible. The compartment thus formed should be made air tight; see Fig. 7.

Space Between Front Edge of Draft Sheet and Smokebox Front.—The space between the front edge of the draft sheet and the smokebox front is very important, and in no case should the area between the draft sheet and the smokebox front be less than the area under the draft sheet. It is preferred to have the table plate extend forward from the center of the exhaust stand as little as possible, providing only sufficient plate to attach the smokebox netting and the draft sheet.

Space Below Table Plate.—Too much attention cannot be given to keeping the space below the table plate free from any obstructions which may hinder the free flow of gases from the firebox.

The importance of the brick arch construction is emphasized since it plays a most important part in the combustion process. The net area over the arch at the rear end should be within the limits recommended in Chart 2 in order to provide ample space for the passage of the gases of combustion and yet confine the stack loss to a minimum. Care should be taken to see that the arch is free from holes. For best results the arch should be sealed at the throat sheet. The use of "Toe" brick at the throat sheet is usually accompanied by and accountable for excessive stack loss, smoke and unequal draft distribution.

Recommended Design of Smokebox Details

The diameter of the smokestack will be obtained from Fig. 4 using that dimension which, in even inches, provides an area closest to that recommended. This should be the minimum diameter at the choke.

A two-piece smokestack, consisting of the stack proper and stack extension, is recommended. The stack proper should have a tapered bore throughout its length, the taper being 1 inch in diameter in 15 inches of length. While this taper is preferred, satisfactory results may be obtained with stacks having a taper of 1 inch in diameter in 12 inches of length. It is recommended that the stack taper be kept within these limits, namely 1 inch in diameter in 12 inches to 15 inches of length. Where the design permits, it is recommended that the entire length of the stack proper be made 30 inches.

The stack extension should have a parallel bore equal to the minimum bore of the stack and end in a flare 28 inches to 32 inches in diameter, depending on the size of the stack. The flare should be approximately 15 inches in length and designed with a long sweeping curved surface. The length of the stack extension will be determined by other conditions and should be such as to provide a space 15 inches to 16 inches in height between

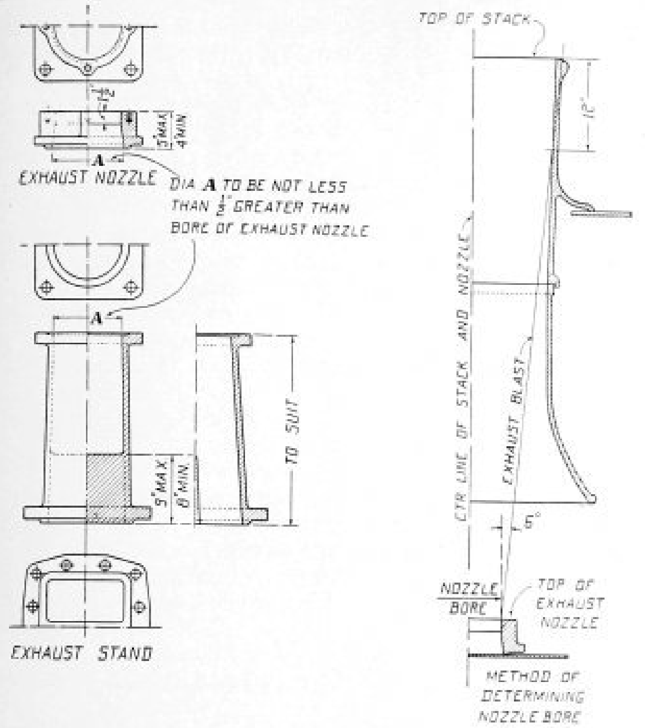


Fig. 9.—Exhaust stand, exhaust nozzle and method of determining the nozzle bore

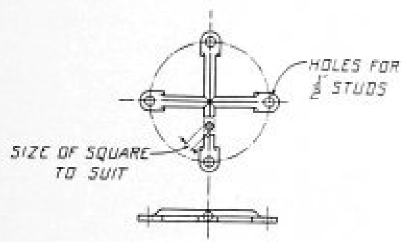


Fig. 10.—Cross spreader

the top of the exhaust nozzle and the bottom of the stack extension. Fig. 8 illustrates the recommended design of stack and stack extension.

The recommended design of exhaust stand is illustrated in Fig. 9. It will be noted that no provision is made for expansion of the exhaust steam within the exhaust stand as has been done in some designs. The barrel of the exhaust stand should taper directly from the rectangular shape at the bottom to the cylindrical at the top. The parting rib in the bottom of the stand should be 8 inches to 9 inches in height. The design illustrated is applicable only to two-cylinder locomotives.

Attention is directed to the note on Fig. 9 stating that the bore of the exhaust stand at the top should never be less than ½ inch greater than the bore of the maximum diameter exhaust nozzle used.

Experiments have been in progress for years to develop the "perfect" exhaust nozzle. As a result there are several nozzles of radically different design in use. The most recent experiments were those conducted at the University of Illinois by Professor Young. In his tests practically all designs of exhaust nozzles now in use were tried and the efficiency of each determined by its ability to provide a steam jet which would entrain the greatest volume of air. It was determined by Professor Young that the ordinary round bore nozzle, when provided with some sort of a spreader or bridge to roughen the steam jet, is, for all practical purposes, the equal of any other type.

Because of its simplicity of construction and widespread use, as well as its proved efficiency, the round-bore exhaust nozzle is recommended. Fig. 9 illustrates the recommended design. No provision for the blower is made in the nozzle. The bore should be parallel for approximately 1½ inches, and the total height, 4 inches to 5 inches. The bore of the nozzle at the junction with the exhaust stand should never be less than ½ inch greater than the bore of the largest diameter exhaust nozzle used.

When making changes in the bore of the exhaust nozzle to improve steaming qualities, it is suggested that increases or decreases in the bore be made in increments of ¼ inch with nozzles of 8-inch bore and over. For nozzles under 8-inch bore the changes should be made in increments of ⅛ inch.

In the course of the tests made while redrafting locomotives various types of exhaust-nozzle spreaders or bridges were tried. These included the square-bar cross spreader, the basket bridge, the single-bar spreader, and the Goodfellow prongs. Tests were also made with an open nozzle, but without notable success except on yard engines in comparatively light service.

By far the most satisfactory results were obtained with the square-bar cross spreader, and this type is recommended. In making the square-bar spreader the diagonals of the cross section of the bar are perpendicular and horizontal. The recommended design is shown in Fig. 10.

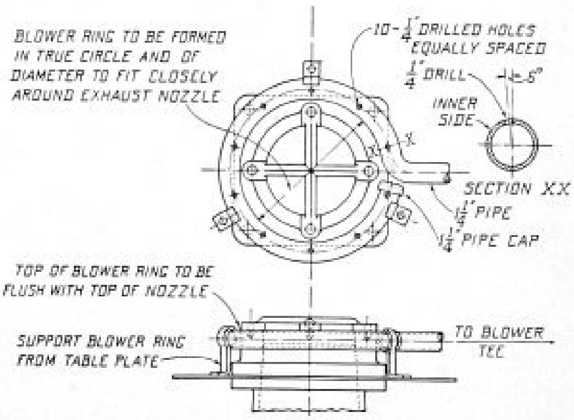


Fig. 11.—Blower design and application

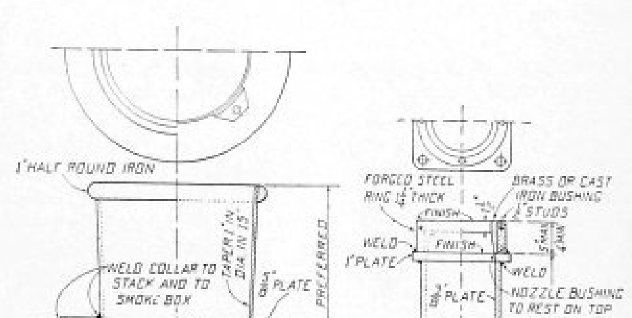


Fig. 12.—Plate smokestack and exhaust stand for experimental purposes

The size of the bar to be used for the spreader depends largely on the size of the nozzle, although there is no fixed rule on this. Based on the nozzle bore, the suggested sizes of the bar for cross spreader are as follows:

Nozzle Bore	Size of square bar for cross spreader
5 in. to 6⅞ in.	⅜ in.
7 in. to 7⅞ in.	7/16 in.
8 in. to 8⅞ in.	½ in.
9 in. and above	⅝ in.

Where satisfactory steaming qualities and fire conditions can be obtained by so doing, it is recommended that the cross spreader rest on top of the nozzle. However, in the course of drafting certain locomotives it may be found that improvement in the fire conditions can be made by setting the bottom edge of the cross spreader ⅛ inch or ¼ inch below and into the top of the nozzle. Likewise, in some cases it may be found that a change in the size of the bar in the spreader will prove of benefit.

In many instances too little attention has been given to the blower design, although the blower is used innumerable times and for indefinite periods during each day's service of the ordinary locomotive. An inefficient blower is wasteful of fuel as well as being unsatisfactory as a draft producing device.

Because of its effectiveness in filling the stack and creating draft, and because of simplicity of construction, the "ring" type blower, made of ordinary 1¼-inch pipe, is recommended. Fig. 11 illustrates the details of the design and the recommended application of the blower.

The draft sheet should be securely bolted to an angle or plate attached to the front end of the table plate and should fit neatly against the sides of the smokebox. While it is recommended that this sheet be applied at an angle of 30 degrees from the vertical, better results are secured in some cases when it is set at a greater or lesser angle than 30 degrees. The bottom edge of the draft sheet should be perfectly straight and perpendicular to the vertical center line of the boiler. A typical application is illustrated on Fig. 1.

A deflecting plate applied at an angle of 45 degrees in the bottom of the smokebox, as illustrated in Fig. 1, is recommended because of its protective value of the smokebox front and because it serves to prevent cinder accumulation at this point. Application of an angle iron across the top edge of this plate as shown has successfully reduced cinder cutting of the smokebox door, door flange and bolts.

In order to provide the details necessary to redraft a locomotive for test purposes without the necessity of having patterns constructed and castings purchased, a smokestack and exhaust stand constructed of steel plate may be utilized. Satisfactory results have been obtained in this manner. A typical plate stack and exhaust stand are illustrated in Fig. 12. It will be observed that a removable bushing, held in place by the cross spreader, is used for the exhaust nozzle. This makes it possible to determine the final nozzle size to be used at a minimum of cost for labor and material.

Assembly of Smokebox Details

Typical Recommended Arrangement.—Fig. 1 illustrates a smokebox and Fig. 2 an arch brick arrangement prepared in accordance with the recommendations outlined. For convenient reference the recommended gas areas are also shown, together with other pertinent data mentioned elsewhere in this discussion.

Points To Be Observed in Assembly of Smokebox Details.—Too much care cannot be taken in assembling the various smokebox details if the utmost efficiency is to be realized. It is essential that there be perfect alinement of the stack and exhaust nozzle. All plates should be applied exactly in accordance with the drawings. The diaphragm plate, table plate and draft sheet should be tight and free from holes.

Test for Steam Leaks.—After applying the exhaust stand a hydrostatic test should be applied. The joints between exhaust stand and cylinder, and between exhaust nozzle and stand should be made perfectly tight during this test. Superheater units should be observed for leaks and tightened if necessary. All pipe joints in the smokebox must be made absolutely tight. Steam leaks in the smokebox can offset the most capable efforts to make a locomotive steam properly and lead to incorrect analyses of the fire conditions.

Test for Air Leaks.—Air leaks are responsible for much of the difficulty encountered in obtaining and maintaining good steaming qualities and economical fuel performance.

A simple test for disclosing air leaks in the front end is known as the "smoke" test and is conducted as follows: Place a cover over the entire top of the stack and then throw a quantity of coal on the fire. All air leaks of consequence will be indicated by the escaping smoke.

Steam Turbo-Electric Locomotive Building for Union Pacific

There will appear early next year on the test tracks of the General Electric Company, at Erie, Pa., a new type steam turbo-electric locomotive which is now being built for the Union Pacific Railroad. This new development in locomotive design is the result of studies conducted by the recently organized research department of the railroad.

The locomotive will consist of two condensing steam turbines, capable of developing 2500 horsepower each and directly connected to 220-volt, 3-phase, 60-cycle, 2250-kilowatt generators. These power units can be operated either alone or in synchronization and will drive six traction motors each, mounted directly on the axles of the driving wheels. It is estimated that the locomotive will be capable of attaining a maximum speed of 110 miles per hour with a trailing load of 1000 tons.

The locomotive and train will be fully streamlined and with both power units operating, the train is expected to be able to mantain the schedule of the Los Angeles Limited, *The Challenger*, and other fast transcontinental trains. One power unit will be able to drive the train on the same schedule now maintained by the streamlined *City of Denver*.

The weight of the locomotive will be about 20 percent less than a comparative type of conventional steam locomotive and somewhat less in weight than the Diesel-electric locomotives now in service. A new type high-pressure oil-fired steam boiler will be installed which, in conjunction with the condensers, will effect considerable economy in operation.

Each of the power units will be of the 4-6-6-4 type with wheel sizes 36 inches, 45 inches, 45 inches, and 36 inches. Sufficient fuel and water will be carried for a minimum continuous run of 550 miles without refueling.

Combustion control systems will be provided that are expected to insure almost smokeless operation. The project is in the nature of an experiment and the results of the tests will decide as to whether it is practical to be placed on regular service. Turbine locomotives, generally of the geared type, are in service in a few instances in England, Sweden, Germany, and other European countries.

Practical Plate Development—XVII

Layout of Cone and Hexagon Intersection

By George M. Davies

The cone and hexagon intersection to be laid out is illustrated in the elevation, Fig. 144, in the plan, Fig. 145, and in the end view, Fig. 146. The center line of the hexagon is at right angles to the center line of the cone.

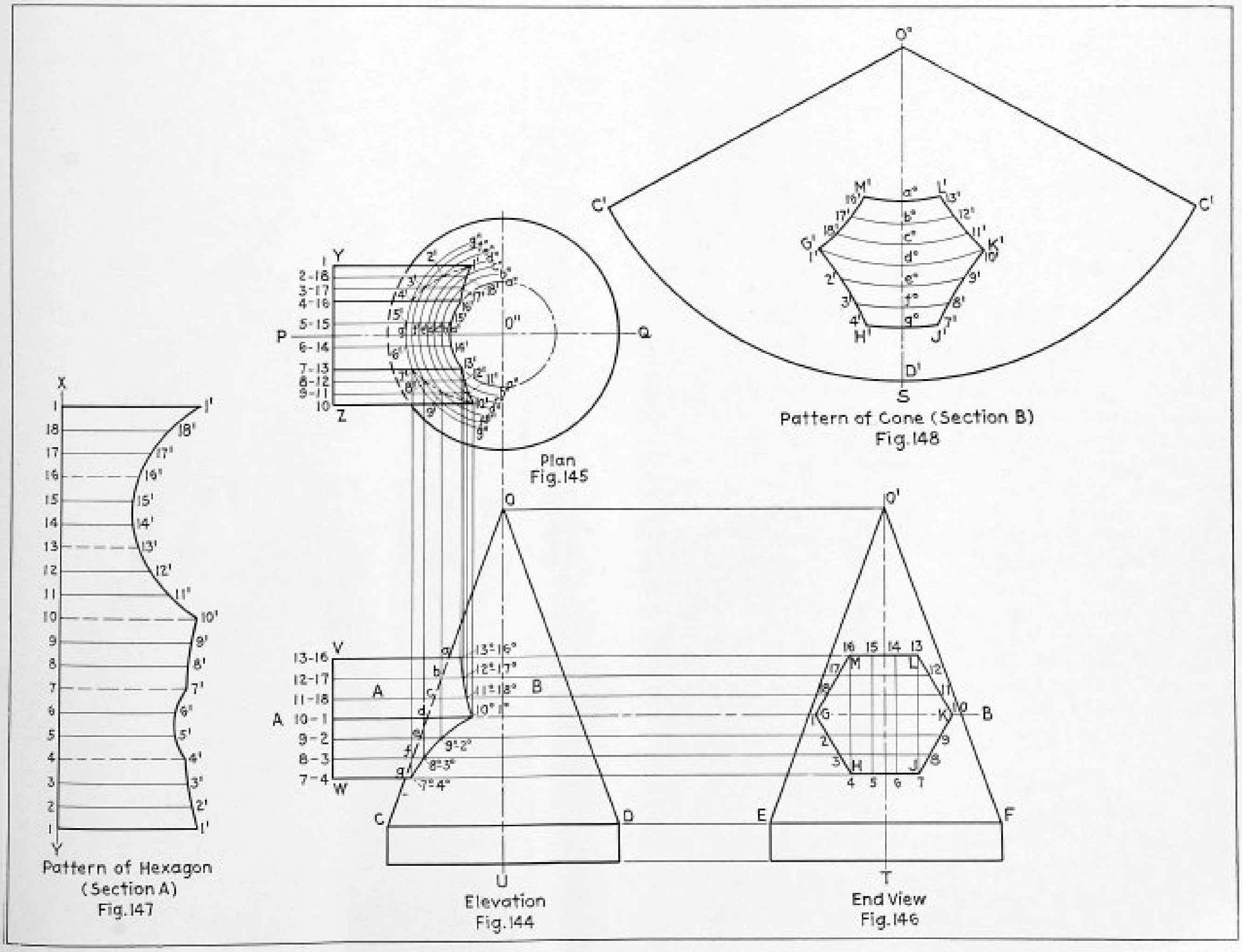
The first step in developing the hexagon and cone is to complete the elevation by determining the miter line between the two objects.

In the end view, divide the perimeter of the hexagon into any number of equal parts that are divisible by six, the greater the number of equal parts taken, eighteen being taken in this case, the more accurate will be the final development. Number the divisions from 1 to 18 as shown.

Draw lines parallel to the center line A-B extending same into the elevation, cutting the line V-W. Number these points on the line V-W from 1 to 18 to agree with their corresponding points in the end view, Fig. 146 as shown.

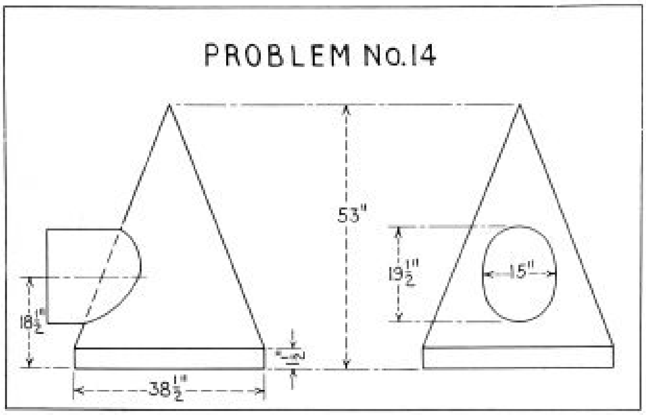
Next on the line Y-Z of the plan, Fig. 145, step off a distance from the line P-Q equal to the distance from the center line O'-T to the point 1 in the end view, Fig. 146, locating the point 1, Fig. 145. In like manner, locate the point 2 to 18 on the line Y-Z, Fig. 145.

Then with O'', Fig. 145, as a center and with the trams set equal to the horizontal distance from the line O-U to the point a, in the elevation, scribe the arc a''-a'-a''. Then with O'', Fig. 145, as a center and with the trams set equal to the horizontal distance from the line O-U to the point b, in the elevation, scribe the arc b''-b'-b''. In like manner, scribe the arcs c''-c'-c'', d''-d'-d'', e''-e'-e'', f''-f'-f'', g''-g'-g''.



Details of layout for cone and hexagon intersections

Problem No. 14 for Readers to Lay Out



The correct solution of Problem No. 14 will be published in the December issue

Next draw a line parallel to the center line *P-Q* through the point 1 and 10 on *Y-Z*, cutting the arc *d″-d′-d″*, locating the points 1′ and 10′, Fig. 145. In like manner, draw lines parallel to *P-Q* through points 2 and 9, cutting the arc *e″-e′-e″*, locating the points 2′ and 9′, Fig. 145. Continue in this manner until the points 1′ to 18′, Fig. 145, are located. Connect these points with dotted and solid lines as shown completing the miter lines between the cone and the hexagon in the plan view, Fig. 145.

Then parallel to the center line *O″-U* draw a line through the point 1′ in the plan, Fig. 145, extending same into the elevation and cutting the line drawn parallel to *A-B* through the point 1 at 1°. Continue in this manner locating the points 2° to 18°, Fig. 144. Connect these points with a line, completing the miter line between the cone and the hexagon in the elevation, Fig. 144.

Development of Hexagon (Section "A")

Draw any line as *X-Y*, Fig. 147, and step off eighteen equal spaces, equal to the spaces into which the hexagon in the end view, Fig. 146, was divided. Number the points from 1 to 18 to 1 as shown. Then erect perpendiculars to the line *X-Y* at each of these points. On the perpendicular to the point 1 step off the distance 1-1′ equal to the distance 1-1′ in the plan, Fig. 145. In the same manner, on the perpendicular to the point 2 step off the distance 2-2′, equal to the distance 2-2′ in the plan, Fig. 145, locating the point 2′, Fig. 147.

Continue in this manner, making the distances 3-3′, 4-4′ to 18-18′, Fig. 147, equal to the distances 3-3′, 4-4′ to 18-18′, Fig. 145, locating the points 3′, 4′ to 18′, Fig. 147. Connect the points 1′ to 18′ to 1′ with a solid line completing the pattern of the hexagon (Section "A").

Development of Cone (Section "B")

Draw any line as *O°-S* and with *O°* as a center and with the trams set equal to the distance *O-C* of the elevation as a radius scribe an arc. Then on each side of the center line *O°-S* step off the distance *D′-C′* equal to one-half of the circumference of the base of the cone. Connect the points *O°-C′* with lines completing the pattern of the cone (Section "B").

To develop the cutout for the hexagon (Section "B").

With *O°* as a center and with the trams set equal to the distances *O-a*, *O-b*, *O-c*, *O-d*, *O-e*, *O-f* and *O-g*, Fig. 144, as radii, scribe arcs, intersecting *O°-S* at *a°*, *b°*, *c°*, *d°*, *e°*, *f″* and *g″*.

On the arc drawn through *a°* step off on each side of the center line the distances *a°*-16′, *a°*-13′ equal to the distances *a′*-16′ and *a′*-13′ in the plan view, Fig. 145, locating the points 16′ and 13′, Fig. 148.

In the same manner on the arc drawn through *b°* step off on each side of the center line the distances *b°*-17′ and *b°*-12′ equal to the distances *b′*-17′ and *b′*-12′ in the plan view, Fig. 145, locating the points 17′ and 12′, Fig. 148.

Continue in this manner until the points 18′, 11′, 1′, 10′, 2′, 9′, 3′, 8′, 4′ and 7′ are located.

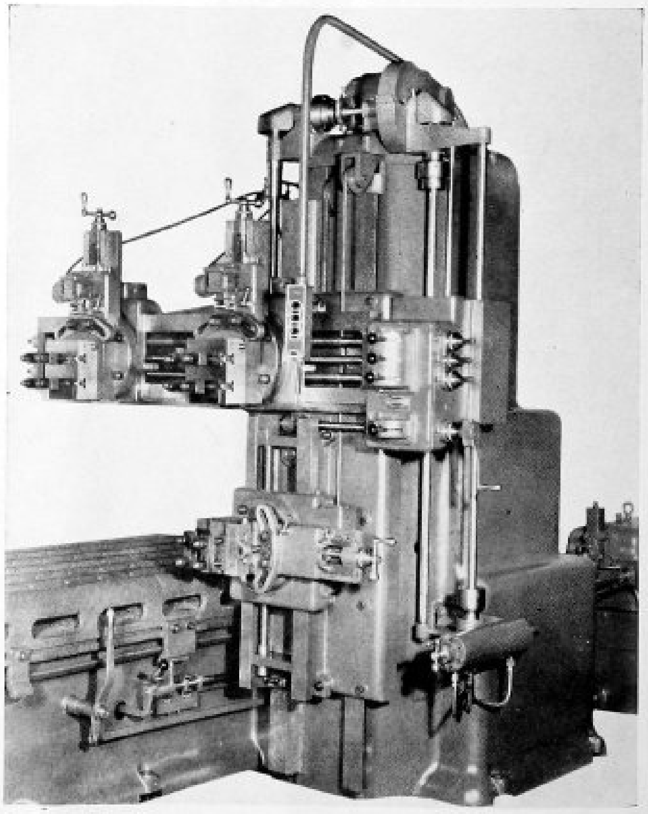
Connect the points 1′ to 18′, Fig. 148, with a line completing the cutout in the cone pattern for the intersection of the hexagon (Section "A").

(To be continued)

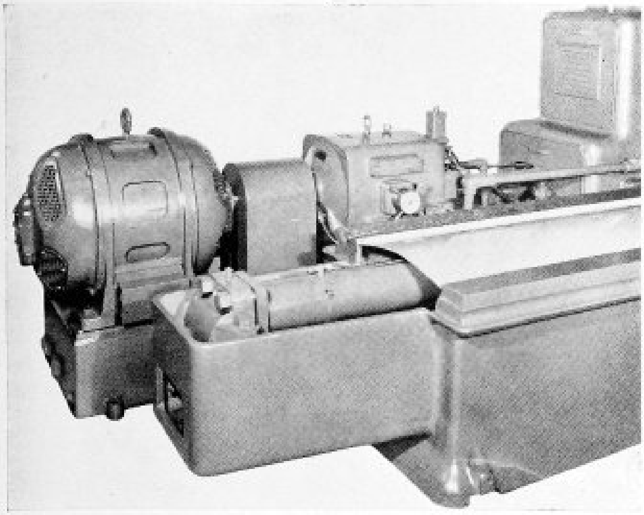
New Hy-Draulic Planer Is Announced

The Rockford Machine Tool Company, 2500 Kishwaukee Street, Rockford, Ill., is now building the Rockford Hy-Draulic planer, in a much larger size than has heretofore been available.

Referring to the illustrations, it will be noted that the "power house" for the machine is at the right-hand end of the bed. This comprises the main driving motor directly connected to the hydraulic power unit, both mounted on a heavy base, and all solidly secured in position. This compact, efficient arrangement is de-



A massive column supports the cross-rail



Power-house end of the planer

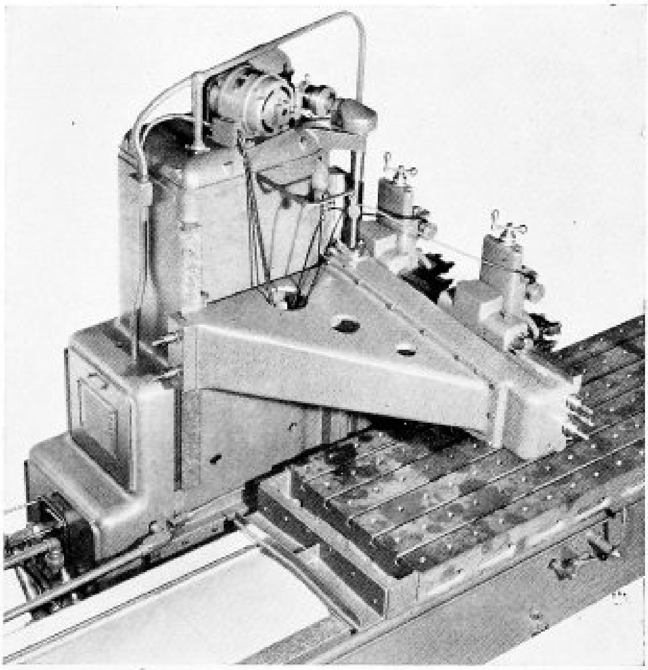
establish the direction of rapid traverse for the rail-head, a master motor switch, and a rod by means of which the machine can be stopped instantly. Three levers provide complete control for the power-operated movements of both rail-heads including feed or rapid traverse to left or right, up or down, separately or in unison. A lowei lever performs the same service for vertical movement of the side-head. By means of a ball crank near the base of the column, the operator can secure instantly any desired feed rate within the capacity of the machine. A lever on the side of the base starts and stops the table movement and an adjacent lever reverses its direction. The rail-heads are equipped with automatic tool-relief devices which raise the tools out of contact with the work during the return stroke. Duplicate controls for starting, stopping, and reversing the table movement are provided on opposite sides of the machine. A heavy sheet-metal cover is provided between the ways which extends the whole length of the bed underneath the table.

signed to reduce the number and length of the necessary hydraulic connections, eliminate vibrations, provide complete protection, accessibility, and ample ventilation. Hand wheels on either side of the hydraulic power unit enable the operator easily to adjust cutting speeds and the rapid-return rate.

The double-length box-section bed has heavy ribbing throughout. The table also is box section and has the customary T-slots, hold-down holes, adjustable control dogs, clean-out openings, chip pocket and tool tray at one end with double oil-wipers at both ends for both ways. The table never overhangs the bed.

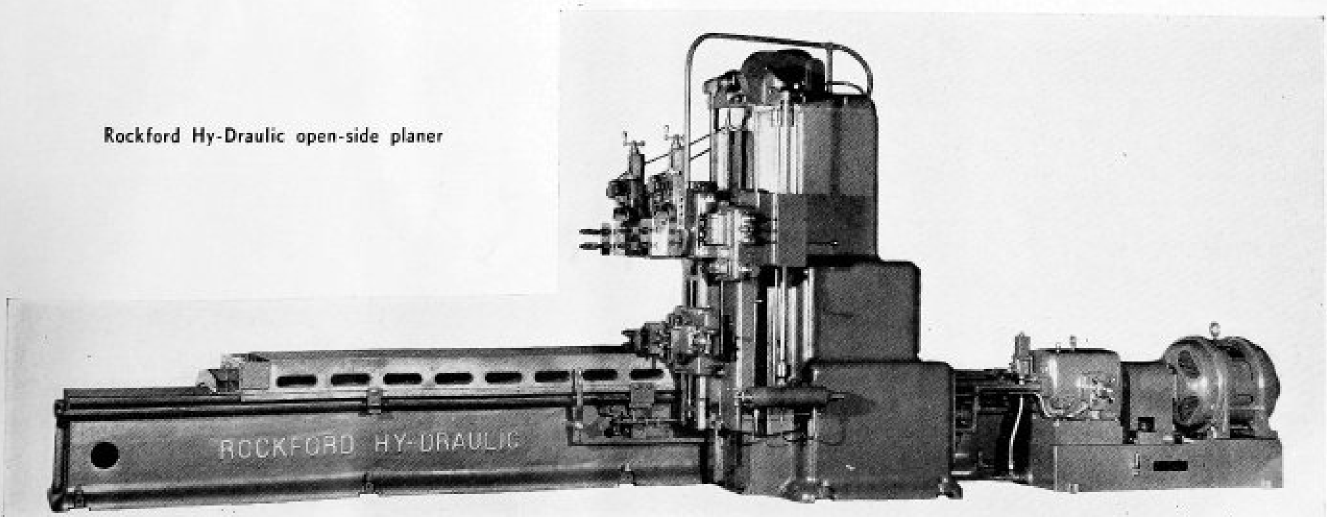
In the center of the machine there is a massive column which supports the open-side cross-rail and contains the electrical and hydraulic control panels. Mounted on top of the column is a motor-driven mechanism which provides rapid traverse to all heads and power elevation for the rail. A large inverted L-shaped casting includes, in one piece, the cross-rail and its long vertical bearing on the column. Securely mounted on this slide is the side-head rail which is pivoted at its upper end and provided with a fine adjustment at its lower extremity. This construction provides a permanent means for accurately alining the side-head rail which is then solidly secured in position by heavy bolts.

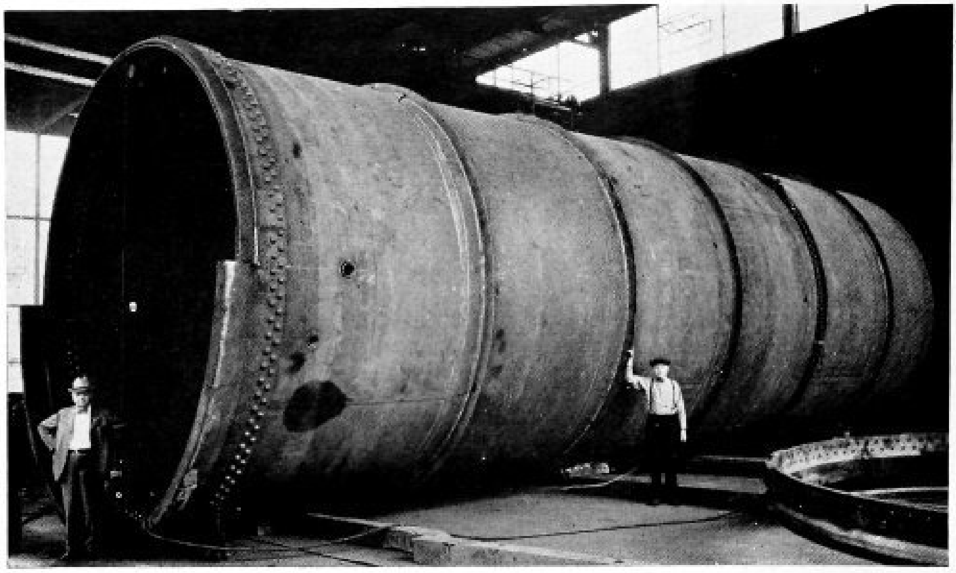
Operating controls are centralized and conveniently located. A pendant contains push-button controls which



The overhanging cross-rail is firmly braced

Rockford Hy-Draulic open-side planer





Huge vulcanizer built to handle large rubber lined tanks for a variety of industrial uses

Goodrich Installs Large Steam Vulcanizer

To meet the ever increasing demand for rubber-lined tanks throughout the steel, chemical, electroplating and other acid handling industries, The B. F. Goodrich Company, Akron, O., is now installing in their plant a new high-pressure steam vulcanizer which is said to be 75 percent larger than any similar unit now in use.

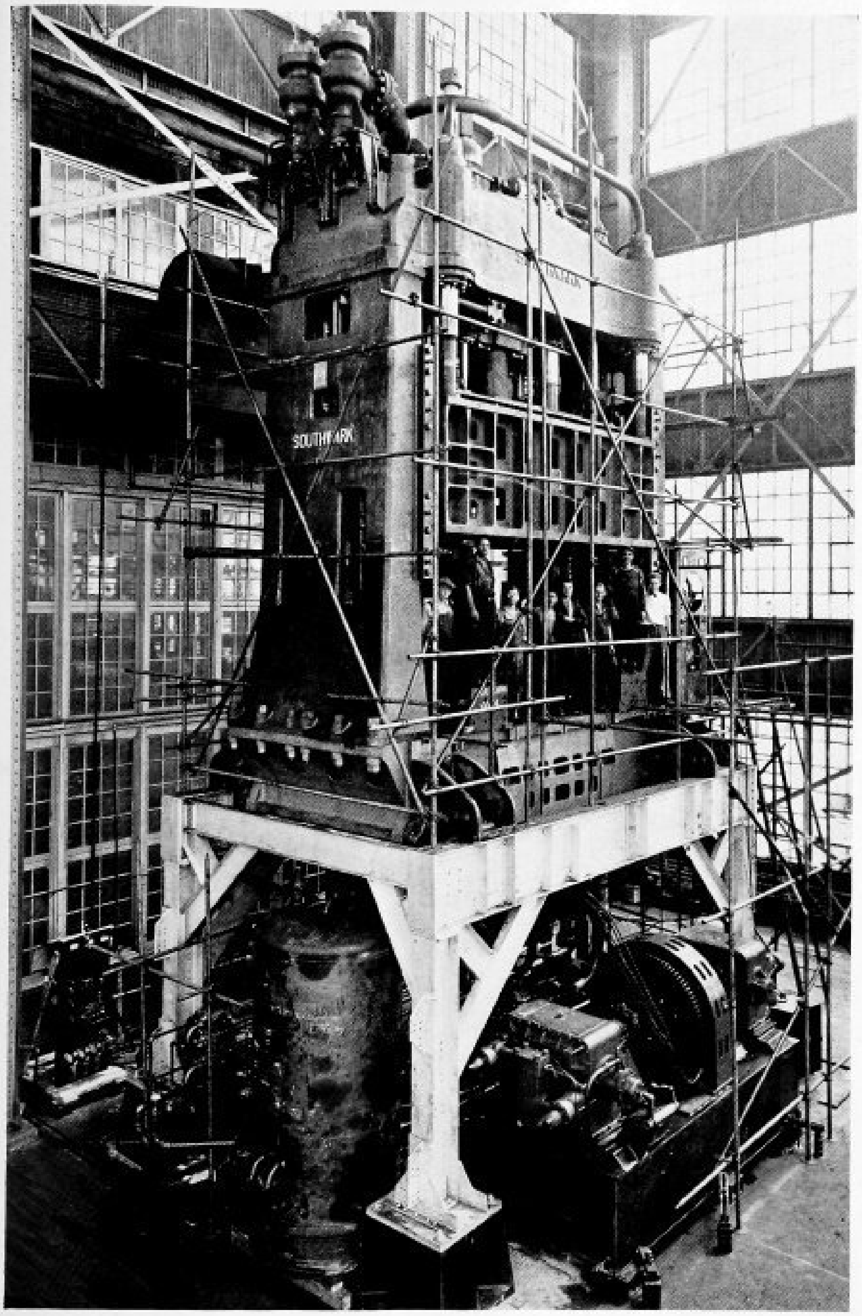
The vulcanizer was fabricated in the shops of the Adamson Machine Company and the Biggs Boiler Works, Akron, O. It weighs 110 tons, is 45 feet long and has a clear inside diameter of 15 feet. Designed to operate at 100 pounds steam pressure, this 65,000 gallon unit is of all-welded construction with the exception of the cast-steel door rings and door head, which are riveted. It has a vertical rising door operated by screws with motor power. A standard gage 90-pound railroad track is installed in the vulcanizer so that tanks can be moved in and out on specially constructed steel cars.

Largest Welded Gas Holder Base Plate

The immense plate of sheet steel, illustrated, 220 feet in diameter and weighing approximately 300 tons, was lowered into place on its foundation on July 16 at the Ford Motor Company's Rouge plant. It will serve as the bottom of a 10,000,000-cubic foot gas holder, and is the first welded bottom plate of this size ever built. During the welding process the plates were held up 3 feet above the foundation by 160 screw-jacks.

When the 300-ton gas-tight plate was finished, a crew of men employed by Stacey Brothers Gas Construction Company, Cincinnati, which has the contract for the gas holder, lowered the plate inch by inch by turning the jacks down. The gas holder is scheduled to be completed late this year and will tower 350 feet in the air, as high as a 35-story building and a little above the great stacks on the Rouge plant power house, largest high-pressure steam power plant in the world.

Hundreds of small plates were welded together to form the base plate for largest welded gas holder



Triple-acting hydraulic press

1000-Ton Hydraulic Press

A 1000-ton triple-acting hydraulic press has recently been completed by the Baldwin-Southwark Corporation, Philadelphia, at their Eddystone plant.

The press utilizes direct-acting hydraulic cylinders—a relatively new development in triple-action presses, features of which are the subject of patent application.

There is a clear distance of 191 inches between the side housings, while the vertical "daylight" of the inner slide is 140 inches, slide up.

Four screw stops on the outer slide allow a varying amount of clamping pressure to be applied at each of the four corners; four cylinders are employed, each with a 42-inch stroke and yielding 400 tons.

For eccentric loading, the inner slide is equipped with a horn type guide. The guide for the inner slide has an equivalent length of 144 inches. This features a patented construction giving a guide length more than equal to the width of the slide. Adjustable bronze gibs are mounted on a rocking backing piece so that full bearing of the bronze gibs is assured. The cylinders acting upon the inner slide produce a pressure totaling 600 tons. A maximum working stroke of 62 inches is available in the inner slide.

The bottom action, which has a 10-inch stroke, consists of two cylinders of 400 tons total. This is used as the third action.

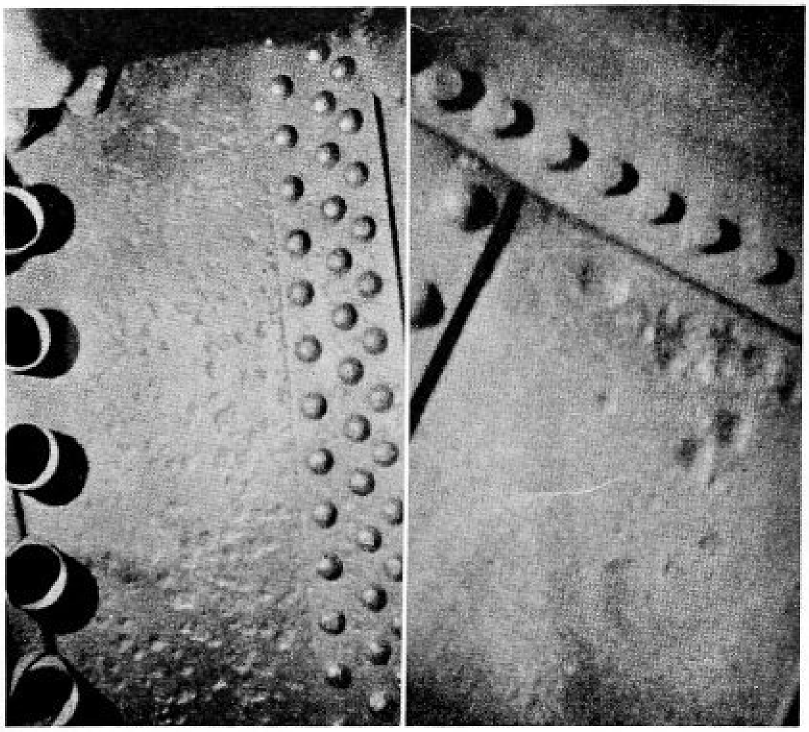
The press is operated by two 285-gallon Northern pumps driven by a 400-horsepower synchronous motor.

An automatic valve in the line to the cylinders which return the slides to their upper positions prevents the slides from dropping in case of motor failure or accidents.

All load carrying members on the machine are either cast or forged steel. The lower cross member, the upper cross member, all slides and cylinders are cast steel, while the tension rods are forged.

Controls, which are of the pushbutton type, fully automatic, are grouped together. All of the most modern safety devices protect the operator from possible injury. For die setting, a sensitive hand control is provided.

Practically four stories in height, the press stands more than 28 feet off the ground, while over 14 feet of the huge machine is below the floor level. The approximate weight of the press is 650,000 pounds.



Characteristic pitting in boilers operated intermittently

Protecting Idle Boilers against Corrosion

By J. P. Morrison*

It is a maxim of dental hygiene that "a clean tooth never decays." Similarly, a clean, dry boiler will not corrode. Power and heating boiler owners who recognize this fact and take advantage of it when boilers are idle during seasons of non-operation find that their boiler investment is longer-lived and their equipment freer from the widespread evils that grow out of extended periods when corrosion is given a freer hand.

To get a boiler absolutely clean and absolutely dry is not an easy accomplishment, but it is one which improves operating experience and prevents accidents. Clean, dry plate in idle boilers is important alike on the internal and external surfaces, and it is the purpose of this article to outline some of the practices which are helpful in achieving the desired end.

Metals in contact with moisture are subject to corrosion, and this action is more rapid in the presence of oxygen, which is found in practically all waters. Corrosion is further accelerated by carbon dioxide gas which also may be present. Bearing these facts in mind, it is not difficult to picture the action which takes place in an idle boiler that is filled with water to the normal working level, entirely filled with water, or empty but not perfectly dry. Under each of those conditions both moisture and gases are present to cause the iron to go into solution and form the scabs and pits that are so frequently found in many boilers.

External corrosion develops quite rapidly when a boiler is taken from service, and when all of the surfaces exposed to the products of combustion are not thoroughly cleaned. The moisture in the atmosphere will condense on a boiler when it contains water that is cooler than the air and this moisture combines with the sulphur in the soot and ash to form a corrosive acid. As a result, there is deterioration evidenced by the presence of a hard substance composed to a considerable extent of the rust from the plates, tubes, headers, etc. The extent of the deterioration is limited only by the amount of moisture, the quantity of soot, and the length of time the boiler is idle.

Unquestionably, there is great advantage and no vital disadvantage in emptying and opening the boiler as soon as the idle period arrives, and some one should be charged with this duty. This work should preferably be done while the boiler is warm so that any moisture will evaporate and be carried off by the natural circulation of the air or, in the case of some parts such as superheaters, by forced circulation, for which a fan or air hose may be used.

Boilers that are to be idle for any length of time should be cleaned thoroughly both inside and outside, using a wire brush on tubes, heads, headers and shell plates, wherever those surfaces can be reached. The superheater, reheater and economizer should be treated likewise. All soot and ash should be removed from the furnace.

These may seem to be extreme recommendations, but they are fully justified since any moisture remaining in the boiler and any soot on the external surfaces increases the rate of deterioration and hastens the need of repairs. These practices have been followed successfully in many cases, even to the extent of using a feather duster on accessible external surfaces.

After the boiler has been thoroughly cleaned and is dry internally, a quantity of unslaked lime may be placed on trays within the boiler to absorb any moisture remaining in the air. The manhole and handhole plates should then be placed in position. If this plan is followed an examination of the lime should be made at about 60-day intervals. A bushel (about 75 pounds) of unslaked lime for a boiler having 2000 square feet or less heating surface with an extra bushel for each addi-

* Assistant chief engineer, Boiler Division, Hartford Steam Boiler Inspection and Insurance Company.

tional 2000 square feet of heating surface should be sufficient where the atmosphere is not excessively humid.

After the external surfaces have been cleaned by removing all soot and ash clinging to the shell plates, tubes and headers, and after the furnace and combustion chambers have been properly cleaned, all access doors should be closed. If the boiler is used for heating purposes, the fire door should be secured in the closed position so there will be no possibility of a fire being built in the furnace of the empty boiler.

As an aid to drying out an empty boiler, for the idle period, the use of a small low-temperature fire of light material, such as excelsior or thin strips of wood, is frequently suggested. There is no question but that such a plan operates satisfactorily if properly carried out under the direct supervision of a responsible engineer, but the temperature of the boiler should be increased slowly and uniformly. At no time should the temperature of any of the surfaces exposed to the heat be excessively uncomfortable to the hand. When there is much atmospheric moisture, salamanders, coke-jacks, or fire pots of other descriptions have been used in boiler furnaces to prevent the condensation of moisture on the external surfaces.

Prevention of corrosion by the application of oil has been discussed by engineers for a great many years. The external surfaces of boilers of some types are accessible and if properly oiled after being thoroughly cleaned may be protected so that no corrosion takes place. However, it is not possible to apply oil to all of the internal surfaces of any boiler. Any surfaces not properly coated with oil are likely to be seriously affected by pitting if there is moisture present.

Oil having a base of animal fat is likely to cause overheating if not thoroughly removed before the boiler is fired up.

The practice of placing a quantity of oil on top of the water and expecting the oil to coat the internal surfaces of the boiler, as the water is drained off, is of practically no value, as oil will not coat a wetted surface.

The fire surfaces of fire tubes, after being sprayed with kerosene to loosen any coating and after being well scraped, may be oiled to prevent corrosion. Of course, when the boiler is placed in service the oil will be burned off, so that no effort is required to remove it prior to starting up.

A stand-by or emergency boiler offers a somewhat different problem. The size of the boiler, the quality and quantity of the water available for refilling, as well as the probability of needing the boiler without advance notice, must be considered.

In some cases such a boiler must be held with a banked fire and carry approximately full working pressure even when it is not placed on the line daily, and must be cared for about the same as if it were in continuous service.

In some central stations where emergency or peak load boilers are kept under pressure, the temperature and pressures are maintained by the use of live steam from the main steam header instead of depending upon banked fires. Boilers operated under such conditions will accumulate little, if any, scale but may be affected by corrosion to even a greater extent than if they were delivering steam.

A stand-by or emergency boiler, that for thirty days or more is not likely to be in service, or which is definitely out of service, should receive the same attention necessary to prevent deterioration that it would if it were located in a seasonally operated plant.

An idle boiler set in a battery with one which is in continuous service may be warmed sufficiently to prevent condensation of atmospheric moisture even when the idle boiler is filled with water and if each boiler is of sufficient capacity to operate the plant, it is much better to operate on an alternate schedule for periods of about thirty days.

With the wet boiler plan, which does not require draining, the boiler, immediately after being taken out of service, should be cleaned and examined by the maintenance crew so that any repairs which are needed can be made promptly. The unit, including the boiler, economizer, and superheater, then should be completely filled with the regular feed water which we shall assume has been treated to produce an alkalinity sufficient to prevent corrosion.

In order to absorb the oxygen contained in the water, sodium sulphite may be added at a minimum rate of about 30 parts per million, which is approximately 2 grains per gallon. The amount of water contained in boilers of various horsepower ratings depends to a great extent upon the type of boiler and will vary from 5 to over 10 pounds of water per square foot of heating surface. The average is about 8⅓ pounds of water per square foot of heating surface. With this ratio in mind a minimum of about ½ pound of sodium sulphite is required for a 150-horsepower boiler. It is necessary to test the water frequently to make certain that an excess of sodium sulphite is being maintained.

To obtain satisfactory results, all boiler valves, and particularly the feed valve, should be absolutely tight, and the automatic non-return valve alone should not be depended upon to keep the boiler closed from the header. If the feed valve leaks, water entering the boiler will increase the pressure and may result in opening the safety valve or possibly discharging water into the steam header.

Taking all facts into consideration, the logical conclusion is that the "dry boiler" plan of caring for an idle boiler is preferable and, furthermore, a boiler cared for in that way is always in condition for inspection. The expense of laying up a boiler dry is probably no greater than when the "wet boiler" plan is followed. The chief advantage of the "wet boiler" plan is that a boiler filled with water can be returned to service in less time and at less expense, provided deterioration during the idle period does not make immediate repairs necessary.

Guide to Government Purchasing Made Available

Guide books for American business firms and individuals desiring to participate in the large market for products purchased by the various branches of the Federal Government were made available on August 21 by the Machinery Division, and Forest Products Division, Bureau of Foreign and Domestic Commerce, Department of Commerce.

The information contained in these publications can be utilized by producers and sales representatives of every kind of merchandise consumed by the Government. The publications offer suggestive leads and shortcuts for contractors interested in obtaining Government business and for prospective bidders on products for Government use. Federal Government purchasing offices, including offices located outside of Washington, are also listed. A section on Government purchasing procedure together with concise instructions for submitting bids.

Copies of either report may be had at five cents each from the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington.

New Republic District Sales Manager Appointed

The appointment of Hoyle Jones as district sales manager with headquarters in Tulsa, Okla., has been announced by N. J. Clarke, vice-president in charge of sales of Republic Steel Corporation. This appointment fills the vacancy caused by the recent death of C. S. Powers, former district manager.

Mr. Jones began his varied and active career in the steel and allied industries in 1904 with the United Zinc and Chemical Company, with offices in his home town

Hoyle Jones

of Kansas City, Mo. This company was later acquired by American Zinc Company and in 1907 he was appointed assistant manager with offices in Chicago. Mr. Jones went to St. Louis in 1908 as manager of the American Zinc Company where he remained until 1910 when he returned to Kansas City as secretary of Jacques Steel Company.

In 1911 he started in business for himself as manufacturers' agent for a number of eastern steel companies including LaBelle Iron Works, Detroit Steel Products Company, Superior Steel Company, Chicago Bridge & Iron Company, and Wheeling Sheet & Tin Plate Company. At the beginning of the war he was appointed manager of sales of LaBelle Iron Works of the western district.

Soon after this country entered the war, his wide acquaintanceship with steel companies in the middle west was recognized and he was commissioned a captain in the Ordnance Department of the U. S. Army. He was stationed at St. Louis with jurisdiction over the production of war materials from the Mississippi river west. Upon discharge from the army in 1919, he organized and become president of Superior Tube Company. He remained as head of that company until just prior to his appointment as district sales manager of Republic.

Metallurgists to Meet at Metal Show

Fifty-seven lectures dealing with every important phase of metallurgical engineering will be presented during the technical sessions of the eighteenth annual convention of the American Society for Metals, to be held in Cleveland, October 19-23 as a part of the National Metal Show, according to an announcement made August 9 by Robert S. Archer, president of the society and chief metallurgist in the Chicago district for Republic Steel Corporation. Features of this year's technical program are the 1936 Edward De Mille Campbell Memorial Lecture presented by J. P. Gill, chief metallurgist of the Vanadium Alloys Steel Company and lectures on "Physical Testing of Metals" by Professor H. D. Churchill, professor of mechanics at Case School of Applied Science, and the three lectures on X-ray by Dr. Kent R. VanHorn, metallurgist at the Aluminum Company of America."

Circulation in Scotch and Watertube Boilers

In answer to the question of how the water circulates in a Scotch boiler and in a watertube boiler, the following explanation is given:

In a Scotch boiler the circulation is started by the water on top of the crown sheets and around the combustion chamber becoming warm and rising to the top. This is replaced by colder water coming in from the sides. Also the spaces between the tube nests have water which is colder than that in the tube nests. The water in the tube nests therefore has a tendency to rise and there is a down current in the spaces between the tube nests to replace this water. There is thus an upward movement of water from the hotter heating surfaces and a downward movement adjacent to the colder surfaces. This establishes a circulation which is assisted in its upward movement by the steam bubbles as they rise from the hot heating surfaces.

The circulation in a watertube boiler is somewhat dependent upon the design of boiler. In a sectional cross-drum boiler, like the Babcock & Wilcox, the water enters the steam drum, goes down the forward headers. The furnace heat causes the water and steam in the lower tubes to go upward into the back headers and then through the upper circulation tubes into the steam drum. The water in the upper tubes is somewhat cooler and these form a return circulation from the back header to the front header. There is, therefore, an upward circulation in the lower tubes and back header and a downward circulation in the upper tubes and front header.

In an A-type express boiler, like Yarrow or White-Foster, the fire row tubes, being the steam forming and hotter tubes, set up an upward flow and cause the back rows to have a downward flow into the lower drum. This circulation being established is increased with the formation of steam from the fire side tubes into the steam drum. There is thus a downward flow in the back, cooler tubes, and an upflow of steam and water in the tubes nearer the furnace. Some express boilers are fitted with down-comer pipes to facilitate the downflow from the upper drums to the lower drums.

Controlling Dust in Industrial Plants

Industrial Dust Control Through Exhaust Systems. By W. O. Vedder. Size, 7 inches by 5 inches. Pages, 51. Illustrations, 9. Fayetteville, Pa., 1936: The Craft Press, Inc. for the Pangborn Corporation, Hagerstown, Md. Distribution by application on company letterhead.

This book is made up to fill an important niche in the industrial executive's library. It charts the progress made by various types of dust control and outlines in easily understood style the advantages of its application. Some of the subjects covered include exhaust hoods and piping systems, the dust collecting equipment, types of collectors in use at the present time, the exhauster and drive, and operation and maintenance of exhaust systems.

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

VOLUME XXXVI NUMBER 9

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BUSINESS MANAGER: Warner Lumbard.

Contents

New President of Pittsburgh Testing Laboratory Elected

According to a recent announcement by the Pittsburgh Testing Laboratory, Pittsburgh, A. R. Ellis has been elected president of this concern, which has been long established in the field of industrial research, inspection, testing, metallurgy, chemistry, welding qualification, etc. Mr. Ellis was born and raised in Pittsburgh and educated in the Pittsburgh public schools. He graduated from Cornell University in 1905, with the degree of civil engineer and entered the employ of the Pittsburgh Testing Laboratory the same year as a laboratory technician. Later, he became an inspector of engineering materials and finally became chief engineer in 1910. His career since then has been manager of the New York branch in 1917, assistant general manager in 1918, general manager and director in 1921, vice-president and director in 1929 and president and director in 1936.

Trade Publications

Steam Traps.—A pamphlet describing the application and operation of a small, lightweight and simply designed steam trap, known as the Yarway, has recently been published by the Yarnall-Waring Company, Philadelphia.

Boiler Feed Filters.—The R. P. Adams Company, Buffalo, has recently issued a bulletin designated No. 401, on the subject of filters for boiler feed water. The bulletin includes discussion and explanation of the operation of the filter, together with illustrations and drawings of the apparatus itself.

Industrial X-ray.—The St. John X-ray Service, Inc., Long Island City, N. Y., has prepared a pamphlet giving a list of the 92 elements with their chemical symbols, atomic weight, melting and boiling points, together with other useful data relating to X-ray work in the industrial field.

Speed Reducers.—Two extensive booklets have recently been issued by the Falk Corporation, Milwaukee, Wis., manufacturer of various types of gears and drives, couplings and steel casing, on its complete line of speed reducers. One, a 56-page publication, describes in detail parallel-shaft speed reducers with both sleeve and roller bearings, while the other, a 60-page bulletin, covers the entire range of right-angle speed reducers.

Buyers' Guide.—The International Nickel Company, Inc., New York, has prepared a complete list of warehouse distributors located in all parts of the United States and Canada, who regularly carry nickel alloy steels in stock. This list has been compiled in the hope that it may be of service to manufacturers and users of machinery and equipment, whose orders for these special steels are generally too small to be obtained direct from the mill.

Edward Valves.—Service requirements for high temperatures and high pressures form the major theme for a new publication designated as Catalogue No. 11-A10, issued by the Edward Valve and Manufacturing Company, Inc., East Chicago, Ind. It is entitled "Valve Material Specifications and Standards" and contains complete chemical analyses and physical rejection limits of all applicable specifications of recognized standing with annotations as to uses, limitations, variations from the basic standards and other comments on valve problems. A portion of the booklet is devoted to dimensional standards.

Seamless Steel Products.—The Seamless Steel Equipment Corporation, New York, has prepared a new catalogue, designated K, which contains interesting information regarding the various manufacturing processes of seamless forged, rolled, and drawn products of high pressure, high temperature requirements. Numerous illustrations are given of seamless steel vessels of special design, as well as tables of standard sizes of steel containers of square, round and irregular shapes.

Forged Steel Flanges.—A bulletin, No. 125, has been issued by the Kropp Forge Company, Chicago, Ill., makers of forged steel flanges. This bulletin includes dimensions, weights, and prices on standard flanges in all sizes from ¾ inch to 24 inches, and engineering data on standard flange facings, drilling templates, pressure-temperature ratings, threading standards, bursting pressures, and the like. Listings include both standard extra heavy and special types of flanges.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Determination of Steam Flow

Q.—Would you kindly publish some information as to the flow of steam in pipes. What velocities should be used in power plant work and how is the flow of steam determined? A. P.

A.—The flow of steam in pipes can be determined with some degree of accuracy, although any formula that may be considered for practical use will not take into consideration the probable drop or loss of pressure, which is dependent upon the length of the pipeline, the velocity of flow, the number of turns in fittings or valves, and the insulation of the pipe.

The formulas for flow of steam in pipes, as given by "Crane," are as follows:

$$V = \frac{A \times B \times 2.4}{C}$$

$$A = \frac{C \times V}{B \times 2.4}$$

$$B = \frac{C \times V}{A \times 2.4}$$

$$C = \frac{A \times B \times 2.4}{V}$$

where:

V = velocity in feet per minute.

A = pounds of steam per hour.

B = volume in cubic feet per pound at given pressure.

C = area of pipe in square inches.

Problem: What would be the velocity of steam in 5-inch pipe to deliver 400 pounds of steam per hour at 150 pounds working pressure (saturated)?

Area of a 5-inch extra heavy wrought-iron pipe is 4.813 square inches.

Volume in cubic feet per pound at 150 pounds working pressure is 3.012 (taken from steam table as found in Engineering Handbook).

Substituting in the formula we have:

$$V = \frac{400 \times 3.012 \times 2.4}{4.813}$$

$$V = \frac{28{,}915.2}{4.813}$$

$$V = 6007 \text{ feet per minute.}$$

Reasonable velocities for flow of steam in pipe based on average practice are as follows:

Steam	Pressure pounds per square inch	Reasonable velocity feet per minute
Saturated	0 pound—15 pounds	4000 to 6000
Saturated	50 pounds and up	6000 to 10,000
Superheated	200 pounds and up	7000 to 20,000

Locomotive Blow Down

Q.—What is the purpose of the continuous blow down on a locomotive boiler, and how does the blow down operate? B. L.

A.—The purpose of the continuous blow down on locomotive boilers is to prevent foaming by controlling the concentration of dissolved and suspended solids in the water by blowing down a fixed amount of water continually.

This is accomplished manually or automatically. Fig. 1 illustrates a manually operated blow down which consists of (See Fig. 1):

(A) ¾-inch blowoff cock.

(B) Blowoff cock handle. The handle is notched so that the blowoff cock can be held in open position.

(C) ¾-inch self cleaning strainer and cleanout.

(D) Cleanout drain.

(E) Barco flexible joint between engine and tender.

(F) Condensate pipe in tank, the pipe should be of sufficient length so as to reduce the pressure of the blow down.

(G) Orifice nipple which definitely controls the amount of water to be blown down.

Fig. 2 illustrates the National Aluminate Corporation's continuous blow-down system which consists of (see Fig. 2):

(1) An angle valve tapped into the firebox wrapper sheet, between the two bottom rows of staybolts and as near to the back of the firebox as is practical. This valve is always open.

(2) An orifice nipple which definitely controls the amount of water to be blown down.

(3) A "Nalco" automatic valve. This automatic valve is actuated by steam from the steam pipes or steam chest.

When the throttle is opened steam passes into the automatic valve and builds up sufficient pressure to open the automatic valve against the boiler pressure. The waste water passes through the automatic valve to the separator (4).

On engines equipped with feed-water heaters, the steam to operate the automatic valve can be taken from the feed-water pump steam pipe. In this case the blow down operates when the feed-water pump is working. This is often desirable, as it reduces the amount of pip-

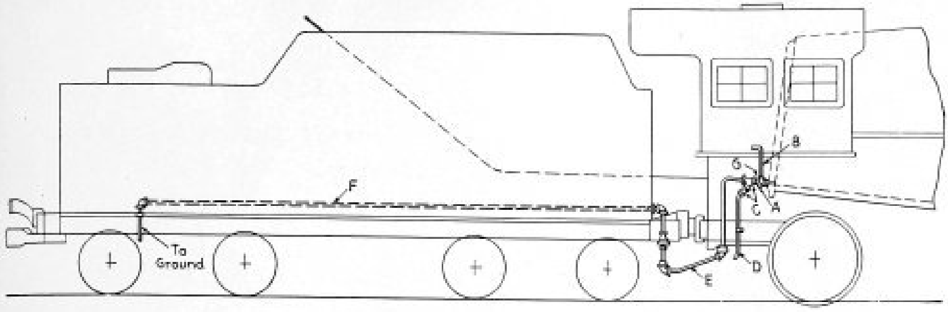


Fig. 1.—Manually operated blow down

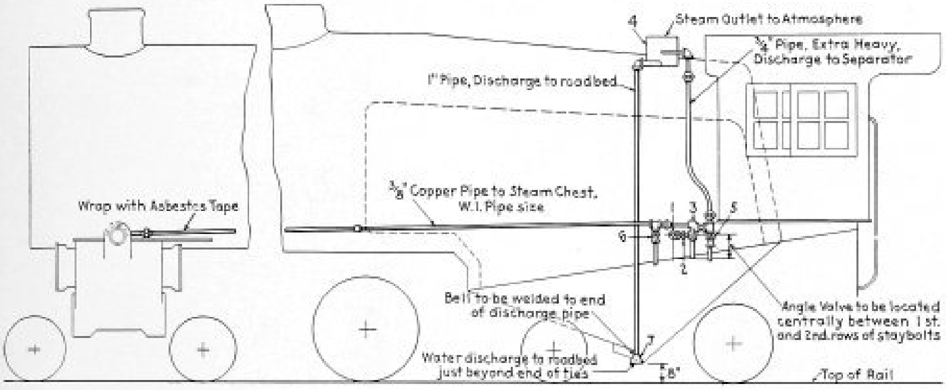


Fig. 2.—Continuous blow down system

ing and eliminates the long pipe to the steam chest, which is oftentimes difficult to keep clear in zero weather.

On engines equipped with centrifugal feed-water pumps the automatic valve can be actuated by pressure from the feed-water pump pressure discharge pipe.

(4) Steam and water separator. This separator divides the steam and water and reduces its velocity so that the steam passes out at the top as a vapor and the water is passed through the discharge pipe to the road bed.

On locomotives where it is found impractical, due to clearances, to place the separator on top of the boiler, it is placed down between the frames and the steam is passed through riser pipes to the top of the boiler. The riser pipes should have a cross-sectional area equal to the area of the outlet in the top of the separator. Provision must be made between the riser pipes and the separator to allow for the expansion of the boiler, when the separator is fastened to the locomotive frames. The water is passed through the discharge pipe to the road bed.

(5) Automatic drain valve for draining the separator.

(6) Automatic drain valve for draining the steam line.

(7) Water discharge pipe bell.

The bore of the orifice is dependent upon the amount of dissolved solids in the water. Should the dissolved solids be over 100 grams per gallon, it indicates that something is wrong with the continuous blow down apparatus. As a rule, it is not voiding a sufficient amount of water.

Ash Pan Air Opening

Q.—How is the amount of air opening in a locomotive ash pan determined? Is it based on the amount of coal required to operate the locomotive? F. B.

A.—The amount of air opening required in a locomotive ash pan is generally computed from the boiler tubes and flues.

The most common practice is that the air openings in the ash pan should not be less than one-hundred percent of the total tube and flue area, with the possible exception of narrow firebox locomotives used in switching service, where this percentage may be as low as sixty percent of the total tube and flue area.

To determine the required air opening of the locomotive whose tube layout is shown in Fig. 1:

First obtain the net cross-sectional area of the flues with the superheater units in place as follows:

Internal cross-sectional area of 5½ inches O.D. tube—No. 9 B.W.G. thick = 21.27 square inches.

External cross-sectional area of 1½ inches O.D. superheater pipe = 1.77 square inches.

Each superheater unit is composed of four pipes, therefore the total cross-sectional area will be

$4 \times 1.77 = 7.08$ square inches.

$21.27 - 7.08 = 14.19$ square inches net cross-sectional area of one flue.

From Fig. 1 we note that there are:

230—2-inch O.D. tubes

36—5½-inch O.D. flues.

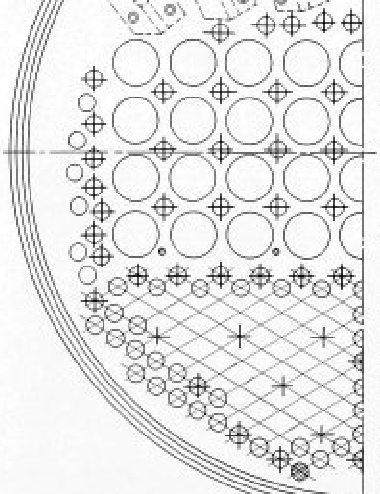
The total cross-sectional area of the tubes and flues will be:

The internal cross-sectional area of one two-inch O.D. tube Number 12 B.W.G. thick = 2.49 square inches.

$230 \times 2.49 = 572.7$ square inches.

$36 \times 14.19 = 510.84$ square inches.

1083.54 square inches—total.



Tubes-No. of 230, Size 2", Holes in F.T. 2 1/32" Dia., B.T. 1 7/8" Dia., Pitch F. and B. 2 3/4"
Flues-No. of 36, Size 5 1/2", Holes in F.T. 5 19/32" Dia., B.T. 4 5/8" Dia.

Fig. 1.—Example of tube layout

The boiler having a tube layout shown in Fig. 1 would require 1083.5 square inches of opening in the ash pan. On wide fireboxes the openings are provided on all sides directly under the firebox ring. On narrow fireboxes with deep pans the openings are provided in the sides of the ash pan itself.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—John M. Hall, Washington, D. C.
Assistant Chief Inspector—J. A. Shirley, Washington.
Assistant Chief Inspector—J. B. Brown, Washington.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Director—Joseph B. Weaver, Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 95 Liberty Street, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—D. S. Jacobus, New York.
Acting Secretary—M. Jurist, 29 W. 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—William H. Furman, Albany, N. Y.
Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.
Vice-Chairman—F. A. Page, San Francisco, Cal.
Statistician—L. C. Peal, Nashville, Tenn.

International Brotherhood of Boiler Makers, Welders, Iron Ship Builders and Helpers of America

International President—J. A. Franklin, Suite 522, Brotherhood Block, Kansas City, Kansas.
Assistant International President—J. N. Davis, Suite 522, Brotherhood Block, Kansas City, Kansas.
International Secretary-Treasurer—Chas. F. Scott, Suite 506, Brotherhood Block, Kansas City, Kansas.
Editor-Manager of Journal—L. A. Freeman, Suite 524, Brotherhood Block, Kansas City, Kansas.
International Vice-Presidents—Joseph Reed, 3753 S. E. Madison Street, Portland, Ore.; W. A. Calvin, Room 402, A. F. of L. Building, Washington, D. C.; Harry Nicholas, 6215 S. Benton Blvd., Kansas City, Mo.; W. E. Walter, 637 N. 25th Street, East St. Louis, Ill.; J. H. Gutridge, 2178 South 79th Street, W. Allis, Wis.; W. G. Pendergast, 1814 Eighth Avenue, Brooklyn, N. Y.; W. J. Coyle, 424 Third Avenue, Verdun, Montreal, Quebec, Can.; A. M. Milligan, 262 Trent Avenue, East Kildonan, Man., Can.; J. F. Schmitt, 28 S. Roys Street, Columbus, Ohio; William Williams, 1615 S. E. 27th Avenue, Portland, Ore.

Master Boiler Makers' Association

President: O. H. Kurlfinke, boiler engineer, Southern Pacific Company, 65 Market Street, San Francisco.
First Vice-President: Franklin T. Litz, foreman boiler maker, C. M. St. P. & P. R. R., Dubuque, Ia.
Second Vice-President: Ira J. Pool, field service representative, National Tube Company, 5610 Merville Avenue, Baltimore, Md.
Third Vice-President: L. E. Hart, foreman boiler maker, Atlantic Coast Line, Rocky Mount, N. C.
Fourth Vice-President: William N. Moore, general boiler foreman, Pere Marquette R. R., 625 College Avenue, S. E., Grand Rapids, Mich.
Fifth Vice-President: Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis (Big Four), 814 Big Four Building, Indianapolis, Ind.
Secretary: Albert F. Stiglmeier, general foreman boiler maker, New York Central, West Albany Shops, 29 Parkwood Street, Albany, New York.
Treasurer: William H. Laughridge, retired general boiler inspector, Hocking Valley R. R., 537 Linwood Avenue, Columbus, O.
Executive Board—Chairman: J. L. Callahan, general boiler inspector, Chicago Great Western, Oelwein, Ia.

American Boiler Manufacturers' Association

President: Starr H. Barnum, The Bigelow Company, New Haven, Conn.
Vice-President: W. F. Keenan, Jr., Foster Wheeler Corporation, New York.
Secretary-Treasurer: A. C. Baker, 709 Rockefeller Building, Cleveland, O.
Executive Committee (Three years); A. W. Strong, Jr., The Strong-Scott Manufacturing Company, Minneapolis, Minn. R. J. Bros, William Bros Boiler & Manufacturing Company, Minneapolis, Minn. E. R. Stone, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. (Two years): E. E. Knoblock, Union Iron Works, Erie, Pa. A. G. Weigel, Combustion Engineering Corporation, New York. J. F. Dillon, Jr., Struthers-Wells-Titusville Corporation, Warren, Pa. (One year): F. H. Daniels, Riley Stoker Corporation, Worcester, Mass. M. E. Finck, Murray Iron Works, Burlington, Ia. A. G. Pratt, Babcock & Wilcox Company, New York. (Ex-Officio): Starr H. Barnum, The Bigelow Company, New Haven, Conn. Walter F. Keenan, Jr., Foster Wheeler Corporation, New York.

Office of Industrial Recovery Committee,
15 Park Row, New York
Manager—James D. Andrew.
Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President — Merle J. Trees, 37 West Van Buren Street, Chicago, Ill.

States and Cities That Have Adopted the A.S.M.E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

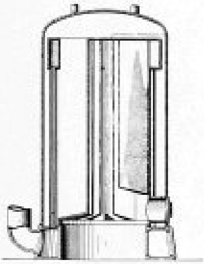
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,865,939. BOILER CONSTRUCTION. WILLIAM F. McPHEE, OF CHICAGO, ILLINOIS.

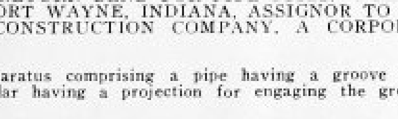
Claim.—A boiler construction comprising a base having a flue chamber, an inner shell and an outer shell disposed upon the base and arranged in spaced-apart relation, a crown sheet having a cylindrical portion of large diameter than the inner shell and a ring secured to the latter, said



inner shell being provided with openings in its side, a plurality of hollow fins secured to the inner shell and having open sides communicating with the openings in the inner shell, the outer edges of said fins being substantially aligned with the inner edge of said ring, the upper ends of the fins being open and communicating with openings in the crown sheet, plates for closing the open side portions of the fins extending between the ring and the crown sheet, and plurality of hollow curved connected with said ring and the base for placing the interior of the inner shell in communication with said flue chamber. Two claims.

1,895,699. ARC WELDING APPARATUS. ADAM ZISKA, JR., OF MILWAUKEE, WISCONSIN, ASSIGNOR TO A. O. SMITH CORPORATION, OF MILWAUKEE, WISCONSIN, A CORPORATION OF NEW YORK.

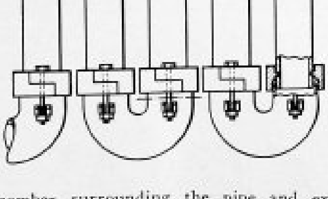
Claim.—In an electric arc welding apparatus in combination a piston for moving the welding electrode, a cylinder in which said piston recipro-



cates, fluid under pressure supplied to the cylinder on each side of the piston, and means responsive to an abnormal characteristic of the arc for varying the pressure of the fluid to cause the piston to correctively alter the arc length. Thirteen claims.

1,893,841. RETURN BEND FOR PIPE COILS. MALCOLM MERRITT, OF FORT WAYNE, INDIANA, ASSIGNOR TO THE WESTERN GAS CONSTRUCTION COMPANY, A CORPORATION OF INDIANA.

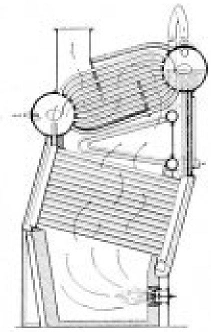
Claim.—Apparatus comprising a pipe having a groove near the end thereof, a collar having a projection for engaging the groove, a recess



in the collar, a member surrounding the pipe and extending into said recess and means for drawing the collar and member toward each other, said collar comprising overlapping segments and said means serving to hold the overlapping segments in assembled relation. Three claims.

1,882,847. BOILER. VIVIAN W. HOXIE, OF SAN FRANCISCO, CALIFORNIA, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

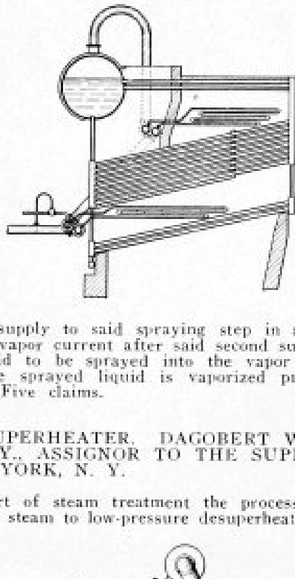
Claim.—In a steam boiler, a bank of inclined tubes connected to headers, a bank of tubes inclined in the opposite direction and located above the



first bank, drums at opposite ends of said last named bank of tubes, connections between said tubes, and means to cause hot gases to pass across the upper ends of the tubes of the second bank and then across the lower ends thereof. Seven claims.

1,889,739. DESUPERHEATER. WILBUR H. ARMACOST, OF NEW YORK, N. Y., ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y.

Claim.—The method of superheating vapor comprising superheating a confined current of vapor, spraying liquid into said current after said superheating step, superheating said current a second time, regulating



the rate of liquid supply to said spraying step in accordance with the temperature of the vapor current after said second superheating step, and preheating the liquid to be sprayed into the vapor sufficiently so that substantially all the sprayed liquid is vaporized prior to said second superheating step. Five claims.

1,894,791. DESUPERHEATER. DAGOBERT W. RUDORFF, OF NEW YORK, N. Y., ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y.

Claim.—In the art of steam treatment the process of changing high-pressure superheated steam to low-pressure desuperheated steam comprising

the steps of first abstracting a large part of the superheat, then allowing the steam to expand to the lower pressure whereby it again becomes more highly superheated, and then finally reducing the superheat to the desired point. Five claims.

Boiler Maker and Plate Fabricator

Progress at Master Boiler Makers' Meeting

Up to 1930 the Master Boiler Makers' Association annually engaged in an elaborate convention which brought together almost the entire membership for several days of technical and social activities. Their efforts were wholeheartedly supported by mechanical officials throughout the country.

The depression changed all this, however, and only by the loyalty and hard work of a small group of officers, headed by the secretary, was the association enabled to survive. Nevertheless, it did survive and against heavy opposition from certain railroad groups, defended its right to exist for the service it might perform to the everlasting benefit of the industry.

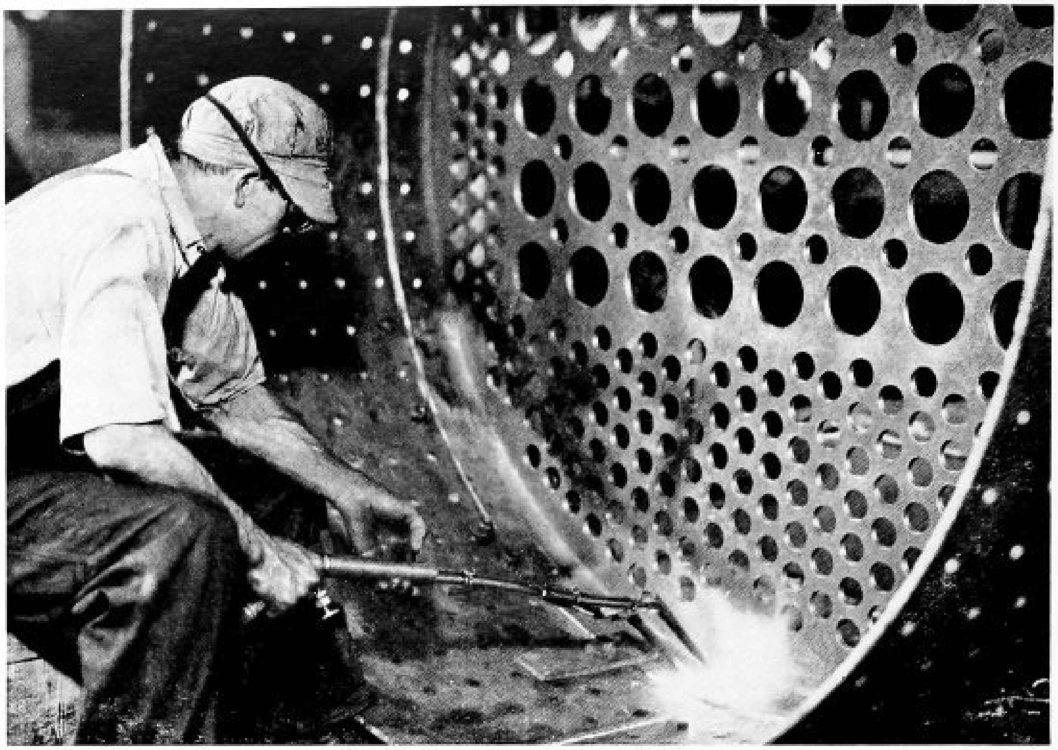
Railroad officials individually have always recognized the value of the work of this group of loyal artisans, and in 1935 supported the effort to revive the association. With a full appreciation of conditions, the officers last year revised their ideas about conventions as such and a new form of activity was initiated—the two-day business meeting. About 125 members and guests took part in the first annual business meeting. Concentrating solely on the matter of determining the changes that had occured in the art of locomotive boiler construction and maintenance over a period of five years and with the objective of developing information of benefit to every railway mechanical department, the members made an outstanding success of their first meeting on the new basis.

The result of this has been evident this year in the increased support and almost complete recognition which railroad officials have given the efforts of the association, withdrawing all opposition to its continuation. This support was apparent in the greatly increased attendance and the spirit with which the activities were conducted. To the end that the association might function efficiently on an entirely modern basis, many of the unwieldy conceptions of organization of the old days were dropped. The by-laws were revised and a new official set-up developed. Heading the association in the future will be a small interested active group of officers, all of whom must acquire experience in the administration of association affairs before they become eligible to higher office.

In another direction, the earnestness and courage of this association has brought about a very desirable condition—the recognition of the supply group which was formed several years ago to work in conjunction with the several minor mechanical associations. For years members of the former Boiler Makers' Supply Men's Association have been dissatisfied with the progress made by the new supply association of which they had become a part. During the master boiler makers' meeting this year, at which many supply company representatives were in attendance, occasion was taken to hold a reorganization session of the Allied Railway Supply Association. This was done with considerable success. New officers were elected who are now being confirmed by the full membership. Plans were outlined, to be developed during the year, which will result in a complete renewal of supply activities in connection with the meetings of all the minor mechanical organizations. Details of the reorganization with the names of officers elected and other pertinent information concerning the Allied Railway Supply Association will be published in a later issue.

Beyond the presentation and discussion of a number of excellently prepared papers covering various phases of the locomotive boiler situation as it exists today, two important addresses were given which merit special comment. John B. Brown, assistant chief inspector of the Bureau of Locomotive Inspection, carrying on the tradition of close relationship between the work of that department and the boiler branch of the railways, presented the views of the Federal Inspection Bureau on the accomplishments being made in the field of locomotive maintenance and repair. A spirit of complete co-operation exists between this official group and association members. The result is evident in the understanding attitude that has prevailed between them for many years. The Bureau unquestionably recognizes the educational work of the association and through its chief has expressed its policy of supporting the endeavors of the master boiler makers as an association.

More than any association event in recent years the presentation of the paper on oxy-acetylene welding and cutting, by a research committee of the International Acetylene Association, indicated full recognition of the job the master boiler makers have in developing repair practices along modern lines. This paper is published in practically complete form in this issue in order that not only the members present at the meeting but the industry as a whole may have the opportunity to study the vast possibilities in adapting this process of fusion welding to their several requirements. In spite of the long years in which this process has been available and the wide experience gained in its use, it was evident by the interest created that few members are doing more than scratch the surface of possible applications. There is a great need for further education in this direction. The policy of inviting authoritative presentations on this and other industrial subjects of a practical nature may well be cultivated as a feature of future meetings.



Using two-hezded heating blow pipe to fit back flue sheet to throat sheet

Locomotive boiler construction and repair applications of

Oxy-Acetylene Welding and Cutting*

International Acetylene Association Research Committee

C. W. Obert, Chairman

J. J. Crowe ***E. V. David***

F. C. Hasse ***H. L. Rogers***

H. E. Rockefeller

The past few years have witnessed some remarkable developments and improvements in the construction of the steam generating equipment of our railroad locomotives. They have advanced to sizes and capacities that were wholly undreamed of a few years ago, and with these increases of power, operating and maintenance problems have developed that require a different treatment than has been customary in the past. It has been necessary in recent construction developments to give thoughtful consideration to repair conditions and problems, as the facility with which the latter are handled determines the availability of the locomotive equipment.

It is the purpose of this report to bring to the attention of the Master Boiler Makers' Association some of the developments and improvements in oxy-acetylene welding and cutting that are of great importance industrially and which also have a strong bearing on locomotive boiler maintenance problems. Your president, Mr. Kurlfinke, has called attention to the necessity of keeping abreast of the times, (BOILER MAKER AND PLATE FABRICATOR, June, 1936, page 137). It is the belief of the members of this committee that the recent advances in oxy-acetylene welding and cutting have been sufficient to keep well abreast of all maintenance requirements in the locomotive boiler field and it is the hope that the data and information here presented may be of real assistance in coping with the exacting problems of modern locomotive boiler maintenance. The committee recommends more careful and serious consideration of the advantages to be derived from the use of the oxy-acetylene welding and cutting processes.

While the subject of this report is broad enough to embrace welded construction of locomotive boilers, it is

* Abstract of paper prepared by Research Committee of the International Acetylene Association for presentation at the annual meeting of the Master Boiler Makers' Association, Chicago, September 16 and 17.

recognized that there are comparatively few details of boiler construction to which fusion welding has been applied in *new construction*, except in cases where the stress due to steam pressure is supported by other means than the welded parts. The question of new construction will, therefore, be treated rather briefly and the major attention will be given to welded repairs and applications of gas cutting thereto. It is the general belief that fusion-welded construction will soon enter into the locomotive boiler field in much the same manner as it has invaded the field of stationary boilers, and it is important that your association be kept informed on the developments.

New Boiler Construction

The extent to which fusion welding has been used in the construction of stationary power boilers is probably generally well-known to the members of this association, but a brief review of this development is here submitted. In 1931 the A. S. M. E. Boiler Code Committee adopted rules for the construction of power boiler shells and drums by fusion welding and these new rules were extended to cover the so-called Par. U-68 (Class 1) unfired pressure vessels intended for the most severe classes of service. About the same time the United States Navy Department issued purchase specifications for fusion welded boiler shells and drums which led to the installation of a considerable number of welded boiler drums and headers on naval vessels. Later on the Bureau of Navigation and Steamboat Inspection adopted similar rules which authorized the use of welded boilers in merchant and passenger steamships. The result has been a healthy development in welded boiler construction in this country during the past five years; it is conservatively estimated that between 3500 and 4000 boiler drums have in this time been fusion welded by the manufacturers comprising the Class 1 Welding Association. At the same time over 10,000 Par. U-68 (Class 1) pressure vessels have been fabricated by fusion welding. It is of interest to state that none of these welded boiler drums or pressure vessels has given any trouble or showed any signs of distress in service.

In the railroad field, an initial step toward welded boiler construction has just been taken by the Delaware & Hudson Railroad in its application to the I. C. C. Bureau of Locomotive Inspection for permission to operate a completely welded locomotive boiler. Under the special ruling granted for experimental operation of such a welded boiler, the American Locomotive Company is building a typical wide firebox type of locomotive boiler in which all barrel, wrapper sheet and firebox joints will be fusion welded under specifications that agree in detail with the construction requirements given in the A. S. M. E. Power Boiler Code for welded boiler drums and shells; the welding used is to be checked by tensile, bend and specific gravity tests of sample welded test plates and all longitudinal and circumferential joints are to be X-rayed, with the entire boiler shell to be stress relieved after welding and before the staybolts are inserted. The barrel of this boiler will be of $1\frac{1}{16}$-inch plate, and its diameter will be 94 inches at the back, tapering down to 88 inches at the front end. The firebox section which is designed for a 132-inch by 114-inch grate, will be formed of $\frac{5}{8}$-inch wrapper plate and $\frac{3}{8}$-inch firebox sheets. This experimental boiler design will effect a considerable saving in weight and the elimination of rivets and butt straps will not only aid cleaning operations, but also go a long way toward prevention of embrittlement troubles.

Oxy-Acetylene Welding

At a number of past conventions your members have discussed the use of fusion welding in connection with locomotive boiler maintenance problems, and our committee realizes that the subject is not new to you. Many members are undoubtedly well versed in the application of oxy-acetylene for both welding and cutting, but it is the belief of this committee that if the advantages of the

Oxy-acetylene welded piping on a locomotive

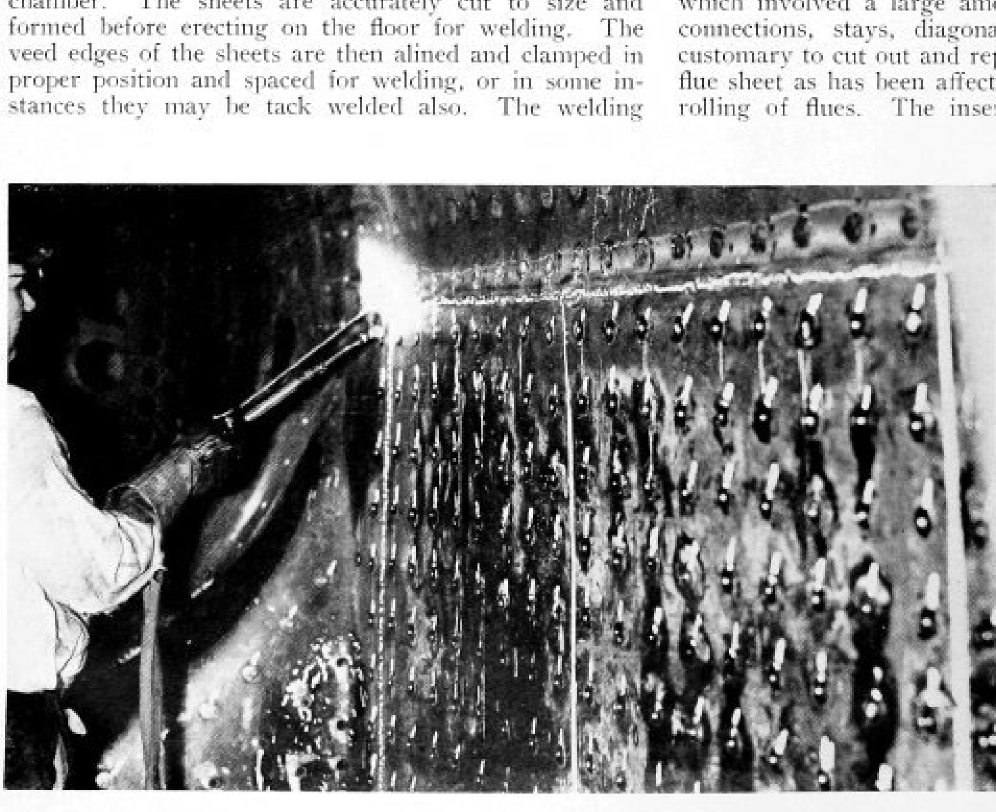
oxy-acetylene process for welding and cutting were more generally understood, it would be much more widely used, to the ultimate economic advantage of the railroads. Very few of the railroad shops are using oxy-acetylene welding to the extent that is permissible under the existing Federal rules, and an attempt will be made in this report to point out some of the possible applications that may not have been adequately covered in earlier reports of your fusion welding committees.

First, reference will be made to welding practices that have become most firmly established in railroad shops, such as the welded repair, patching or replacement of internal stayed sheets, including firebox crown and side sheets, combustion chamber sheets and tube sheets. Welding has long been acceptable for repairing such parts, as the safety of the structure has not been considered dependent upon the welds when the sheets are adequately staybolted. There have been certain limitations imposed upon the extent of welding that is permissible in such stayed surfaces, such as the welding up of many adjacent corroded spots or the insertion of several adjacent welded patches; under conditions such as these it is generally required that the entire defective sheet be cut out and replaced by a new sheet which may be butt welded to the adjacent firebox sheets as long as the welded seams are located between adjacent rows of staybolts. Such welding in staybolted areas, including the installation of the thermic syphons, has become standard practice on a majority of the railroads, where it has been used for periods of many years with very satisfactory results; experience has proven that the application of welding for this purpose has greatly reduced repairing costs and delays and still has fulfilled all requirements for safety in operation.

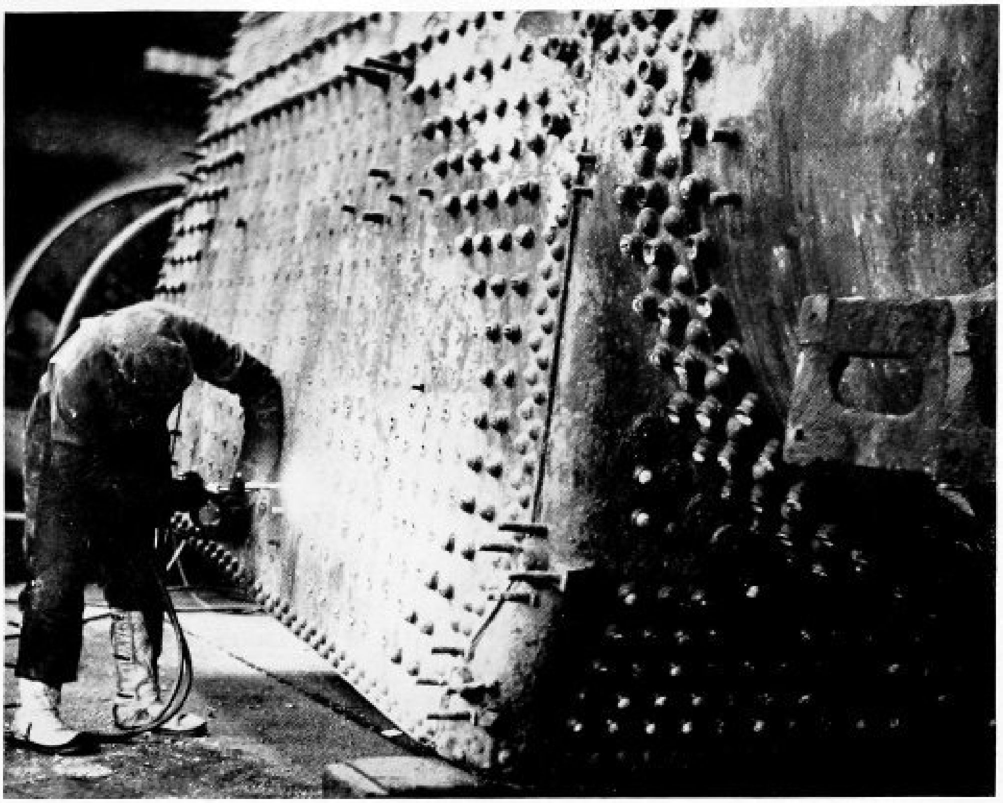
When a complete new firebox is to be applied to a boiler it will on many railroads be completely welded with any longitudinal welds between crown sheet and side sheets kept down 12 inches below the top of the crown sheet. Transverse welds are permitted between the crown sheet and the door sheet and also between the crown sheet and the back flue sheet in the combustion chamber. The sheets are accurately cut to size and formed before erecting on the floor for welding. The veed edges of the sheets are then alined and clamped in proper position and spaced for welding, or in some instances they may be tack welded also. The welding should be applied progressively in such a manner as to avoid bulging or warping of the sheets at the end of a seam, and the welding of a seam when once started should be carried on continuously to completion without stopping or delay. The welds should under these conditions be of the double-V type or equivalent. The door hole opening should preferably be formed to permit of butt welding the flanged-in edge of the sheet, or an offset or curved inserted sheet may be used with a butt welded attachment to the door sheet and an arrangement for lap welding to the outer sheet flange. Where syphons are installed they should be fitted into the crown sheet with butt welds, while at the back flue sheet the neck of the syphon should be welded to the diaphragm plate with a corrugation to accommodate expansion and contraction.

There are many cases, however, where only a part of a side sheet is found corroded to the point of necessitating renewal and the rest of the firebox sheets, including the crown sheet, are capable of rendering further service. Welding permits that part of the side sheet to be replaced with a minimum of delay and cost. With the oxy-acetylene torch or blowpipe, any desired portion of a sheet may readily be cut away and when the new sheet is formed and trimmed to shape and size, it can be welded into place to replace the part removed. Both the edges of the replacement sheet and of the parts left in place are veed and then alined for welding. The welds in this case are usually of the single-V type as the water side of the welded seam is usually inaccessible for welding on the reverse side. Here also the welding of such seams should be carried along continuously without stopping or delay when once started. This form of side sheet repair has proven so successful during the past few years that it has caused a great reduction of complete firebox replacements. Where it was formerly customary to fit nearly every locomotive boiler overhauled with a new firebox now every such boiler has only one or two side sheets or parts thereof replaced.

Flue sheets also occasionally require renewal and it was formerly the practice to replace the entire sheet which involved a large amount of work in removal of connections, stays, diagonal braces, etc. Now it is customary to cut out and replace only such section of the flue sheet as has been affected by corrosion, or by overrolling of flues. The insert section is carefully fitted



Using the oxy-acetylene welding process for welding new side sheets into the firebox of a locomotive



It has been definitely established that cutting staybolts by the "washing method" with the torch does not damage the plate

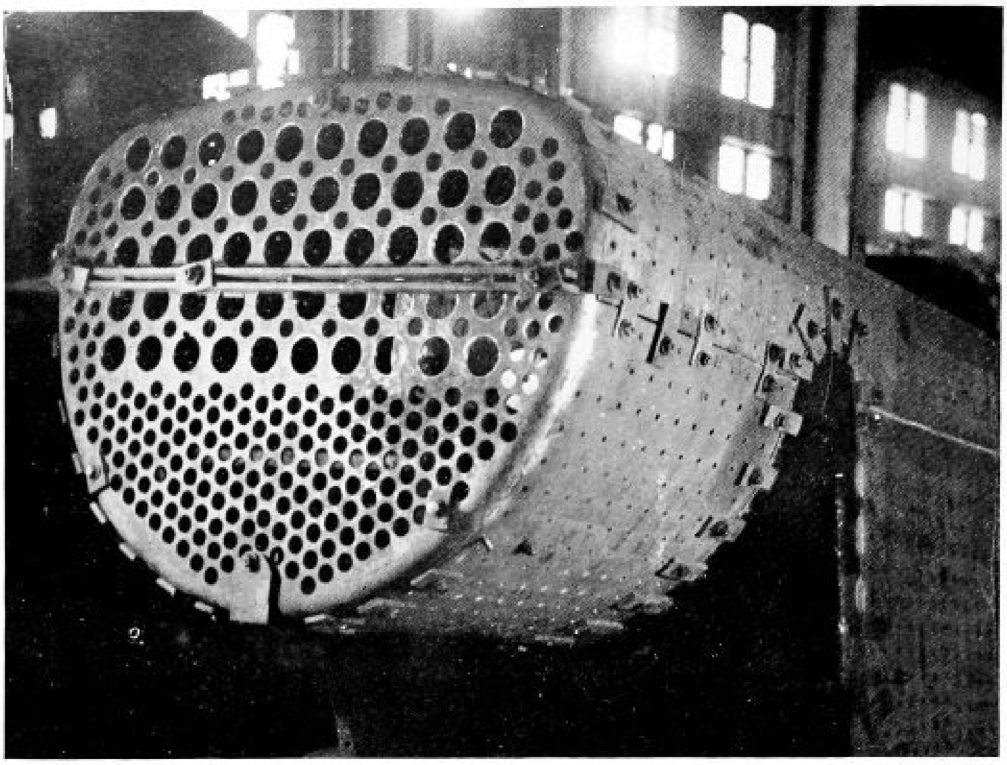
and the edges veed for welding in much the same manner as for a side sheet patch. Where the section extends to either side the edge of the sheet is flanged like the edge of a flue sheet and then the flange is bolted into position which helps greatly in alining the sheet for welding. Where an entire upper part of a flue sheet is to be replaced, the upper weld is located between the top row of flue holes and the bottom row of boiler braces. Where welds are carried across through flue holes, the flue holes may be welded in solid and then drilled in place, or the holes may be trimmed by the gas cutting torch to approximate size and then reamed to finish size.

In firebox repair work, conditions of corrosion, or enlarged staybolt holes, often require the renewal of a portion of a sheet by an insert patch. When such a patch does not extend to the mudring, but is over two rows of staybolts in extent it is desirable that the patch be formed with curved edges of such a shape that the edges pass between holes. The patch is then carefully fitted into the area where renewal is required and the edges veed out for welding from the firebox side. Before insertion of the patch it is given a dish, corrugated, or offset so as to permit of such deformation during contraction of the weld as may be necessary to relieve localized stresses. The patch is then inserted and held in place by clamps and/or machine bolts inserted in staybolt holes, after which the patch is tacked and welded in place.

Cracks are successfully welded shut in firebox sheets provided it is possible to offset or otherwise deform the sheet on either side thereof so as to allow for the contraction after welding. Such cracks often extend through staybolt holes, which tends to indicate that the furnace sheet has been subject to stress at that point. In such cases it is more necessary than otherwise to bend or offset the sheet to a considerable extent before proceeding with the welding. In such cases the staybolt holes should be welded solid and then drilled after the welding has been completed. It is not considered desirable to repair a cracked sheet in this manner if the crack extends over two rows of staybolts in extent; when longer than this a patch should be inserted.

Staybolt holes after extended service tend to become enlarged and ofttimes cause radial cracks adjacent to the hole. In such cases, and particularly after renewals of staybolts, the holes become enlarged to an extent where either larger sizes of staybolts must be inserted, or the holes must be reduced in size and retapped. In some shops it is customary to ream out the holes to a considerable extent oversize and insert welded steel sleeves or bushings, the holes in which are of correct size for tapping for the standard staybolt; this practice is preferred by some shops for the reason that when the hole in the welded sleeve or bushing becomes enlarged the bushing may be cut or driven out and replaced by a new one. The use of such sleeves or bushings is, of course, unnecessary when oxy-acetylene welding is available for reducing the diameter of oversize holes. It is a very simple operation to close in such oversize staybolt holes by depositing metal from a ⅛-inch welding rod, and then ream and tap the hole to the standard staybolt size. This practice is followed extensively in many shops, and by use of the proper welding rod weld metal can be deposited which is readily reamed and threaded. Tests have shown that there are no undesirable results on the plate from the welding operation, and if pains are taken to deposit the weld metal so as to obtain a proper union with the plate the holes can be tapped so as to obtain strong, sound threads. (See Appendix No. 1.)

Cracked or broken mudrings can be readily welded by the oxy-acetylene process without the necessity of removing the ring from the waterleg. If the firebox is not to be removed a section of the side sheet adjacent to the part to be repaired is cut away for access to the mudring which is then veed out so as to obtain access through the entire section of the ring. Weld metal can then be



Locomotive firebox with combustion chamber fitted for welding—the welding operator is working inside

deposited until the entire section is closed in, taking care to obtain good fusion of the deposited metal with the sides of the vee. After the weld is completed a patch is inserted in the side sheet and then the mudring rivet holes can be drilled and the rivets inserted.

Where the firebox is removed from the boiler shell and the mudring is cracked or otherwise requires repairing, it is customary to remove the mudring also and either restore the cracked section by welding, or insert a new section to replace a corroded part, if necessary. In either case the cracked section or the edges at points of joining should be veed out on both top and bottom sides and welded in solid until the full section is reached. It is desirable that the welding of the two sides should be carried out simultaneously by two welding operators, which can be accomplished by setting the ring up in vertical position so that one operator can weld on either side. When the welds are completed they should be finished to size by hammering while hot. In case of insertion of a new section in the mudring, clamping bars should be used to fasten the sections in proper alinement with the rest of the mudring, which may be readily accomplished by bolting through the rivet holes in the original mudring.

Extensive use has been made of oxy-acetylene welding in the repairing and safe-ending both plain and superheater flues. In case of plain flues the prevailing practice has been to butt weld the safe ends; whereas in superheater flues the safe-ends have, in certain instances, been inserted and lap welded. In the case of butt welding the safe-ends should be mounted and held in true alinement with the flue to be extended, the veed ends being separated by about $\frac{1}{16}$ inch. Under these conditions very little reinforcement is permissible and it is, of course, essential that the welding be applied so as to leave the interiors clear and smooth.

Also extensive use has been made of oxy-acetylene welding for filling in pits and corroded areas on the exterior surfaces of flues. It is not unusual, upon examination of flues after rattling, to find occasional pits of depth equal to half of the wall thickness or more on the water side; such pits would, if not repaired, mean early leakage and failure of the flue. However, where these pits are filled in with weld metal the life of the flue is greatly lengthened.

Other applications of oxy-acetylene welding to superheater units include attachment of the cinder guards that are used at the curved smokebox ends to protect them from the abrasive scour of the cinders. These and also the superheater unit binder clamps are readily and firmly attached by welding.

There are a number of other applications of oxy-acetylene welding around the typical locomotive boiler that are worthy of consideration, including such details as superheater headers, exhaust pipe castings, cinder netting and frames, steam pipe connections and fittings, safety valve bases, injectors, feed-water heaters, etc., etc. Also the pressure air, steam and water piping on the boiler offer fruitful opportunities for welding applications in both new piping installations and maintenance work. Welded piping exhibits a degree of freedom from leakage as compared with threaded fittings that is very important.

Tenders and sheet-metal cabs offer opportunities for oxy-acetylene welding applications that come within the range of the boiler shop welding department. These embrace not only new construction of tender tanks and cabs, but also repairs and replacements of sheets, stiffeners or parts by sheet sections or patches. Oxy-acetylene welding permits of butt joints in the thinner gages with great facility, and this materially enhances the appearance of the finished work. In a few instances tenders have been lengthened to afford greater capacity by gas cutting apart and inserting extensions of both underframe members and tank sheets by oxy-acetylene welding.

One of the most important applications of oxy-acetylene welding to a cast-iron pressure part, is on cylinder castings which are generally of cast-iron construction.

Oxy-acetylene cutting is widely used not only in the construction but also in the repair of locomotive boilers, and also it has a wide application in scrapping them when worn out or obsolete. Hardly any other process utilized in connection with boiler work finds such universal application for as wide a variety of purposes. The ease, economy and speed with which these operations are performed by oxy-acetylene cutting are not approached by any other available method.

Oxy-Acetylene Cutting

The oxy-acetylene cutting process consists in preheating ferrous metal to its kindling or ignition temperature and then rapidly oxidizing it with a closely regulated jet or stream of oxygen issuing from a cutting blowpipe or torch. Oxygen has a remarkable affinity for ferrous metals, raised to or above kindling temperature, which phenomenon forms the basis of gas cutting. Hence, the process is primarily a chemical one.

When commercially pure oxygen is brought into contact with most steels or iron, at kindling temperature, the chemical reaction which results in a very active one. In cutting plain carbon steel, the metal is preheated to a bright red color (in daylight) reached between 1400 and 1600 degrees F. Both gases supplied and cutting speed are closely controlled so that only the metal within the direct path of the oxygen jet is acted upon. In linear cutting, or severing, a narrow race or kerf is formed, having uniformly smooth and parallel walls. Under skilled workmanship, using mechanically moved and guided torches or blowpipes, cutting tolerances as to squareness and longitudinal alinement of the cut surface may be held within very close limits.

The faces or walls of the cut or kerf, in the commonly used carbon steels, are not injured by the cutting operation. On the contrary, their strength and toughness are slightly improved. The heat effect upon the metal resulting from normal cutting operations rarely penetrates more than approximately 0.1 inch below the cut surface in any case.

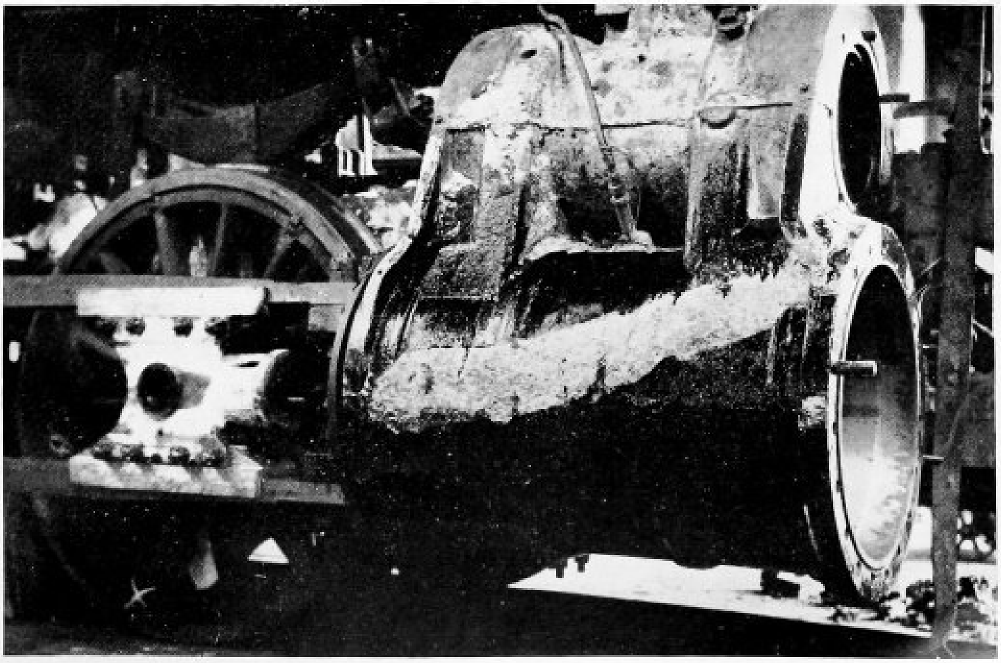
In addition to the chemical reaction in cutting, there is a noticeable and helpful mechanical eroding effect produced by the kinetic energy or motive power of the cutting oxygen stream. This washes away considerable of the molten steel in unconsumed or metallic form, thereby adding to the efficiency and economy of the process.

Gas Cutting Equipment. Gas cutting equipment consists ordinarily of the cutting torch or blowpipe with separable cutting tips of different sizes, oxygen and acetylene hose with connections, oxygen and acetylene pressure regulators, and gas cylinders or other supply of gas. The pressure regulators usually are equipped with cylinder and working pressure gages. Cutting oxygen regulators are designed especially to deliver oxygen in larger volumes and at higher pressures and, hence, usually are fitted with 400 pounds per square inch working pressure gages.

Where large quantities of oxygen are required, oxygen cylinders often are manifolded. Acetylene generators, rather than cylinders, are used where the consumption justifies them. For such installations, distribution pipe lines frequently are employed to carry both gases to the various points of consumption throughout the premises. In machine gas cutting, the torch or blowpipe is held and operated mechanically, but its essential features and the accessory equipment are the same. To assure safety and efficient results, the manufacturer's instructions for setting up and operating the equipment should be followed closely in each case.

Selection of Cutting Tip. A wide variety of cutting tips or nozzles of different styles and sizes is available for oxy-acetylene cutting, designed to suit every conceivable type of work. They provide for cutting various thicknesses of most ferrous materials and for different surface conditions, such as clean, painted, rusty or scaly surfaces. The thickness of the material to be cut governs the selection of the tip or nozzle having the correct diameter of cutting oxygen orifice, as a rule. Surface conditions and chemical composition of the material are also considerations in selecting a cutting tip having the right intensity of preheat flames. The manufacturer's instructions for selecting proper cutting tip should be consulted. Rusty or scaly surfaces often are cleaned along the line of cut before cutting, by cracking the scale loose either with the torch preheating flames or mechanically with scrapers or chipping hammers.

Starting Cuts. In most cases, flame cuts are started at the edge of the piece. The cutting torch or blowpipe is held so that the ends of the preheating flame inner cones just clear the surface of the material. When a



Extensive fracture in a locomotive cylinder repaired in place by means of bronze fusion welding spot of metal at the top of the edge has been heated to a bright red, the cutting oxygen jet is turned on. The metal in the immediate path of the cutting jet oxidizes and, as the torch is moved slowly and steadily along the line to be cut, separation is effected. In flame cutting ordinary steel, the tip should be held vertically at an even distance above the surface and advanced uniformly at the proper speed, without wavering.

Piercing Holes. In starting a flame cut in the metal away from the edge, or in piercing a hole, more time usually is required to bring the spot to the kindling temperature, than with edge starting. When a spot has been heated to a bright red, the torch or blowpipe is raised about ½ inch above the normal position for line cutting and the cutting oxygen turned on slowly. As soon as the work is perforated, the torch is lowered again to the normal height above the surface and the cut completed. Drilled holes are used for certain work, particularly to form a straight, smooth starting edge for a heavy internal cut.

Drag and Quality. In flame cutting, the cutting oxygen jet usually enters the cut vertically to the surface, in line with the cutting oxygen orifice axis. After traversing about one-half the thickness of the cut, however, it may curve backward in a direction opposite to the travel. When this occurs, the amount by which the oxygen jet falls behind the perpendicular in passing through the material is known as the "drag" of the cut. Faint markings or ridges called "drag lines" left on the face of the cut enable this to be measured. Drag may be increased by either increasing the cutting speed or reducing the cutting oxygen pressure. In fact, the drag can be made to increase until the cut no longer penetrates entirely through the material. However, if the drag is excessive, slag which is hard to remove will adhere firmly to the bottom of the cut. On the other hand, to reduce the drag below a certain amount, a sharp increase in cutting oxygen consumption is required.

Satisfactory gas cuts must have a drag sufficiently short for the purpose intended and to allow cutting the final corner and "dropping" the piece. The sides of the cut should be sufficiently square and smooth—not grooved, fluted or ragged. There should be no firmly adhering slag on the bottom of the cut, as this requires an appreciable expenditure of labor for its removal. With proper adjustments, only loose slag or none at all is obtained. Finally the upper and lower edges of cut should be sharp enough to meet the requirements of the particular job.

Straight line cuts usually may be made with considerable drag, without much detrimental effect, as the drag lines lie within the plane of the cut and do not prevent both top and bottom edges of cut being left clean and sharp. This procedure saves considerable oxygen. However, in shape cutting, when rounding curves or corners, less drag is permissible, as the bottom contour of the cut will tend to come out differently from the top, with the edges not square. Such cuts must be made with small drag and are known as "high quality" cuts. Precision machine flame cuts are necessarily of high quality.

Bevels. Angular or bevel flame cuts are made as easily as square cuts, by either inclining the tip and torch sideways to the desired angle, or by using a bent tip. Such cuts may be made by hand or machine, both in straight or irregular lines, and with the same depth range as in normal right-angle cutting. Beveled edges are widely used to prepare plate edges for welding, for mitering purposes and to modify sharp corners.

Machine Flame Cutting. For many operations, the advantage of mechanically holding, guiding and advancing the torch or blowpipe over the work was recognized early in the history of flame cutting. It was evident that, wherever practicable, this would better workmanship, accuracy and economy. Flame cutting machines have been developed to fill this demand which today are comparable with machine tools.

They are capable of making flame cuts with jig-saw flexibility and of such high quality and accuracy they frequently require no further finishing. Types of machines now available include manual or motor-driven, partly or almost fully automatic, portable and stationary, having various capacities suitable for practically all classes of work of almost any size.

Some machines are equipped with two, or as many as six cutting torches or blowpipes, centrally controlled and guided, and will cut a like number of identical shapes simultaneously, thereby effecting marked economies where high production prevails. Concentric circles for flanges and the like often are cut in one operation, using two or more torches. Still other types of machines will crawl around pipe, making one or two square or beveled cuts, as desired. Nearly every conceivable requirement is covered by the wide assortment of machines now available.

Flame Drilling and Punching. Accurate flame drilling and punching of holes is a development which appears to be well within the scope of the process. Considerable progress is being made in perfecting means of effecting parallel-sided holes. It has been found that the dimensions of the finished hole can be made uniform and its walls straight-sided, provided the nozzle or tip is properly held during the drilling operation. The oxygen lance is also a valuable tool for many flame drilling operations, particuarly those where considerable depths are involved, beyond the reach of ordinary cutting tips.

Tolerances. Where the torch or blowpipe is held firmly and advanced at uniform speed, as in machine flame cutting, cross-cut tolerances can be held within narrow limits. The degree of longitudinal precision of a machine cut depends on the trueness of the guide rails of the cutting machine, the clearance and play of the operating mechanism and the regularity of the propelling unit. Machine flame cuts are frequently so smooth and square and have such sharp edges that, for many purposes, they require no further finishing of any kind. Those unfamiliar with the process find it sometimes difficult to credit flame cutting with the high quality workmanship displayed.

Warping and Buckling. When metal is heated, it expands as the temperature increases. If a part is heated uniformly all over, the forces set up by its expansion are likewise uniform throughout. On again uniformly cooling, the part will return to its original size and form, as regards dimensions and alinement, provided it is lying flat or fully supported, but free to expend or contract in any direction.

If, however, a part is heated locally, as in gas cutting, it is likely to warp or buckle, unless its stiffness is sufficient to resist the forces set up, or suitable preventative measures are taken. These may consist of clamping or otherwise holding the plate or slab firmly in position while cutting and cooling, or making two or more cuts simultaneously or in rapid succession about its neutral axis, thus equalizing the forces set up and neutralizing their effect.

Plates of ½ inch thickness and above are seldom warped or buckled by gas cutting, unless unusually long and narrow. For splitting long narrow pieces, so-called "skip-cutting" is frequently employed. In this method, the cut is made to skip at intervals, depending on the work, leaving a series of uncut sections along the line of cut, each about ½ inch to 1 inch long. These uncut ligaments hold the material in line until cooled, whereupon they are cut through to separate the parts. Sometimes simultaneous cuts, made with two or more torches, moved together along parallel lines, are used to eliminate warpage, increase production and reduce costs. Where unusual accuracy is demanded in overall dimensions of larger cut parts, correction factors must be applied in making the cutting layout, particularly where steel is preheated.

Rivet Cutting. Rivet cutting by surface oxidation of heads has proven a very successful operation. Cutting tips used for this operation have large cutting oxygen orifices of expanding, low-pressure, low-velocity type, together with high-intensity preheating flames. The tip is held in line with the rivet, close to the head, so that preheating flames impinge on its center. As soon as a spot is heated bright red, the cutting oxygen is turned on slowly. This quickly oxidizes a crater in the head and consumes it. The shank of the rivet is then knocked out of the hole. Preheating and oxidation of the rivet head require only a few seconds and unusual speed and economy is secured by this method, particularly where large quantities of closely-spaced rivets are cut. The low velocity and pressure of the cutting oxygen are insufficient to cause the molten slag to fly back against the end of the tip and plug up the holes, so that the torch need not be raised when turning on the cutting oxygen. Plates or sheets are not scored by this improved method.

Staybolt Cutting. Removal of staybolts by the cutting process has simplified this one-time difficult operation. The tip is held in line with the bolt, so that the preheating flames contact and heat the edge of the telltale hole. When heated sufficiently the cutting oxygen is turned on gradually. The torch or blowpipe is then slowly rotated around the telltale hole until the center of the bolt for a depth of ⅜ inch is consumed. The direction of the cut is changed 45 degrees and the bolt pierced through to the water space. By slowly rotating the torch or blowpipe at this same angle the bolt is cut without damage to sheet or threads. The small burr remaining in the sheet is then removed. There are several other fast economical methods of applying the cutting process to this operation which can be and are used to meet special job or shop conditions.

Effect on Steel. In oxy-acetylene cutting of steel, the metal immediately adjacent to the cut is heated red hot, considerably above its critical range, and cooled again through this range. The speed of cooling is dependent upon the heat conductivity of the surrounding metal, radiation losses, and the fact that the heat is applied only momentarily at any given point, the cutting torch or blowpipe being kept in constant motion while cutting. Where the steel being cut is at room temperature, the rapidity of the cooling is sufficient to actually have a chilling or quenching effect on the cut edges, particularly in the case of heavier cuts involving large masses of cold steel.

Microscopical examination of suitably polished and etched specimens taken from gas cut edges shows considerable alteration of the crystalline grain structure of the material to have occurred. However, this change is physical and not chemical. The pearlitic steel has been transformed into an unstable condition, taking on a sorbitic, troostitic or martensitic form, depending on its content of carbon and other alloying elements such as chromium, vanadium and tungsten. Also, there has been an appreciable grain growth at the gas cut edge, due principally to the intensity of the heat developed in the operation.

In oxy-acetylene cutting of low carbon and mild steels, containing not over 0.35 percent carbon, at room temperature, the sorbitic structure is produced. This sorbitic steel has greater strength and toughness and slightly greater hardness than the pearlitic steel of the surrounding base metal. In general, the properties of sorbitic steel are more desirable than those of pearlitic steel. Hence, it may be said that low and medium carbon steels are in no way damaged by gas cutting. In fact, the structure is improved thereby.

Where edges are gas beveled to form a vee for welding, and later are welded together, either by oxy-acetylene or electric process, the heat of the welding operation acts to anneal the cut surfaces and restore them to their original pearlitic structure. Any change in structure that the preceding cutting may have produced in and adjacent to the cut surfaces is obliterated.

The A. S. M. E. Boiler Code Committee recently conducted an investigation of the conditions which develop when the fusion-welding process is applied to a gas cut edge. As a result, all restrictions in the Boiler Code pertaining to welding on surfaces so prepared have been removed. The rules now state that plates may be cut to size and shape by a flame cutting process, provided the carbon content of the steel does not exceed 0.35 percent. These rules stipulate further, however, that gas cut plate edges must be uniform and smooth and that all loose scale and slag accumulations must be removed from them before welding. It is expressly stated in the Boiler Code that the discoloration which may appear on gas cut surfaces is not considered to be detrimental oxidation.

Recent tests of flame cut edges of low and medium carbon steel to determine their physical properties, such as hardness, microstructure, resistance to impact, and ductility have shown that they are satisfactory for almost any type or character of mechancial treatment or service. As compared with sheared edges or friction saw cuts, flame cut surfaces were found to possess considerable advantages. Both shearing and friction sawing were found to inflict more punishment on the surface of the metal than gas cutting. (See Appendix No. 2)

Safety Rules. Certain precautions must be observed for the safe handling and operation of gas welding and cutting tools and appurtenant equipment. Standard Rules and Regulations have been promulgated by the oxy-acetylene industry in co-operation with regulatory bodies dealing with the public and workers' safety. In "Safe Practices Bulletin No. 23" published by the National Safety Council and in "Regulations for the Installation and Operation of Gas Systems for Welding and Cutting" issued by the National Board of Fire Underwriters, the subject of general safety as it applies to gas welding and cutting processes is well covered.

Appendix No. 1

The tests referred to were carried out to determine what effect the reduction of diameter of oversize staybolt holes by oxy-acetylene welding might have on the metal adjacent to the hole. It has been argued by those not familiar with such welding that the weld metal deposited in this manner would be hard or brittle and not adaptable to tapping to receive a threaded staybolt. A search of the literature developed the fact that there is a scarcity of information to answer this specific question.

The test was conducted upon samples of ½-inch flange quality boiler plate steel with staybolt holes 1⅛ inches in diameter. These holes were reduced in size by depositing a ring of weld metal within the holes, about ⅛ inch thick and penetrating the full thickness of the plate. A ⅛-inch welding rod of ordinary low-carbon steel was used and care was taken to obtain good fusion entirely through the hole. The contractural effect from the welding was determined by strain gage measurements across the holes in two directions, both before and after the welding; there was, as might have been expected, definite cooling shrinkage toward the

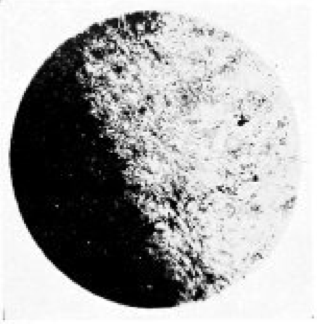


Fig. 1—Flame cutting showing change in structure extending to 1/16 inch depth

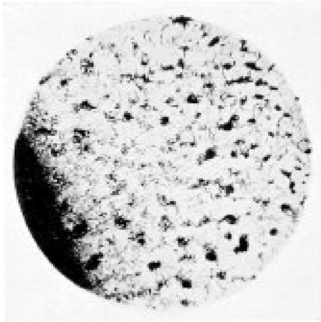


Fig. 2—Flame cutting and grinding, change in structure extending to 1/32 inch depth

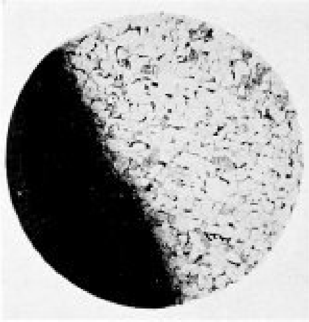


Fig. 3.—Flame cutting and chipping removed evidence of structural change from flame effect

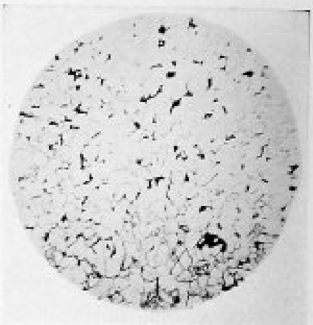


Fig. 4.—Normal grain structure of boiler plate before cutting

holes of amounts varying from 0.0007 to 0.0042 inch, according to the location of the holes in the plate.

After the welding the holes were first reamed and then tapped with a standard 1-inch staybolt tap, and the weld metal in the holes was found to be soft and ductile and entirely free from hard or brittle spots. The resulting threads were clear cut and full and appeared to be entirely solid and sound. As a check on possible hardness adjacent to the holes, the entire area of metal around several holes was sectioned and explored by a Rockwell hardness testing machine which showed a moderate increase in hardness close to the holes where the heat of the welding had penetrated. These readings showed an average of about 74 on the Rockwell B scale, close to the holes as compared with 62 at a distance of 2½ inches from the holes. This represents too little hardening to give any adverse effect in the threads, either from the viewpoint of threadability of the metal or strength of the threads after tapping.

Appendix No. 2

Corroboration of the claim that low carbon boiler plate steel is not adversely affected by flame cutting is to be had from the results of an investigation recently conducted by the Test Department of the Chesapeake & Ohio Railway Company, at its Huntington, West Virginia shops. These tests were undertaken primarily to determine what allowance is necessary to be machined off after flame cutting boiler plate. The results were placed at our disposal for presentation to your association through the courtesy of T. F. Barton, superintendent of motive power of the C. & O. Railway at Richmond, Va.

It was found that in the flame cutting of ⅜-inch boiler plate steel, the effect of heat penetration as shown by change in grain structure was about $\frac{1}{16}$ inch. It was the conclusion that where it is considered desirable to eliminate this heat-affected zone it can be very definitely accomplished by machining off the flame cut edge to a depth of $\frac{3}{32}$ inch.

Accompanying the report are microphotographs which show the effect of the heat penetration very clearly. In Fig. 1, which is a view taken at the cut edge, it is evident that the heat penetration effect is not clearly defined for $\frac{1}{16}$ inch and that this depth is more than ample to cover any trace of change of structure. Fig. 2 shows the flame cut edge after grinding and Fig. 3 the same after chipping. Fig. 4 shows the normal microstructure of the plate for purposes of comparison.

Welding Societies Hold Annual Meetings

American Welding Society Meets at Cleveland

The seventeenth annual meeting of the American Welding Society will be held October 19 to 23 at Cleveland. The Hotel Cleveland will be headquarters for the meeting, at which technical sessions and committee meetings will be held. An extensive exposition of welding equipment will open Monday noon, October 19, at the Cleveland Public Auditorium, which will continue from noon until 10:00 p.m. each day until the convention closes.

A very complete program on all phases of welding has been arranged. Special inspection trips will be held during the course of the week's activities.

Technical sessions will be held for the first three days of the meeting for members of the association. The Thursday meeting on October 22, will be held jointly with the American Society of Mechanical Engineers. Friday the latter association will hold sessions, while the Welding Society group will devote the day to plant inspection trips around Cleveland, or in attending sessions with the mechanical engineers.

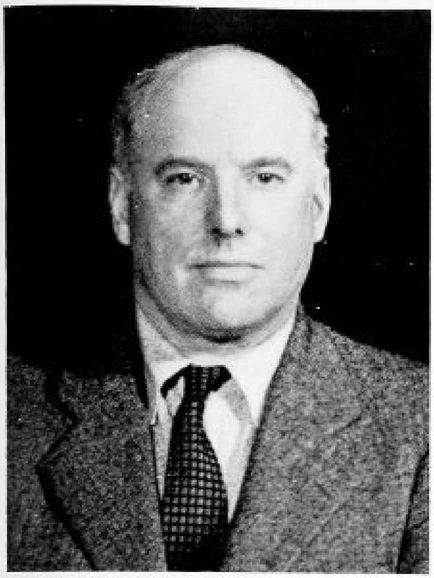
International Acetylene Convention At St. Louis

The International Acetylene Association will hold its Thirty-Seventh Annual Convention in St. Louis at the Jefferson Hotel, November 18, 19 and 20. This will be the first time that the convention has been held in St. Louis.

Technical sessions will be held each afternoon and on two evenings. The oxy-acetylene process for welding and cutting metals will be featured at these sessions. As the result of a year of unusual developments, a series of vitally interesting subjects will be discussed by speakers who are key men in their fields.

Wednesday evening, November 18, is to be devoted to a forum on welding and cutting. The evening session Thursday, November 19, is intended to comprise a series of popular round-table discussions on oxy-acetylene welding and cutting practices.

A cordial invitation to attend this Convention is extended to everyone interested in the practical applications of the oxy-acetylene process.



John B. Brown, assistant chief inspector, Bureau of Locomotive Inspection

Safety in Boiler Repairs

By John B. Brown*

Because of the mutuality of interests of your association and the Bureau of Locomotive Inspection, I appreciate this opportunity to meet with and address you. In common with your association, the interests of the Bureau of Locomotive Inspection center largely on the locomotive boiler. Federal inspection of locomotive boilers was brought into being by the recognized necessity of compelling common carrier railroads to equip and maintain their locomotives with safe and suitable boilers and appurtenances. Your association was organized about five years earlier and had done excellent work before Federal boiler inspection became effective. We have grown up together and each has been successful in performing its intended functions, otherwise we would not be here today for the purpose of equipping ourselves better for performing today's work and looking forward to the future.

Progress in the design and construction of boilers has been especially rapid within the last few years—within the memory of many of the members of this association. It is a far cry from the first tiny boiler that converted heat from a hot cast-iron block into steam of low pressure to the modern high-pressure boiler, in the firebox of which combustion may occur at the rate of fifteen tons of coal per hour, evaporating almost enough water to float a ship. Nevertheless the period of time in which this transition occurred is comparatively brief. We have, however, not reached the ultimate. In progressing further we must temper our enthusiasm with caution, in order to maintain our safety standards.

The steam boiler is a potential destroyer of life itself if not designed, constructed, inspected, repaired, and operated with an ample margin of safety. If we do not give proper weight to safety, progress will be retarded and needless human suffering will result.

Because the ability to create is one of the greatest sources of satisfaction and contentment, it is only natural on the part of man to desire to bring forth, or to assist in bringing forth, something new, something different; we all like to have our names linked with progress. Unfortunately for solid, substantial progress, we always have with us those who attempt to take a short cut to fame or fortune, those who make claims that they have done, or are doing, new things with great success, when in fact the alleged accomplishments are largely figments of the imagination.

The lesson of all this is that each of you should rely on your practical experience and on recognized engineering principles as a test for the probable suitability and sufficiency of proposed methods or devices. It is true that if we are to make progress we cannot solve our problems through our own experience and knowledge alone, and that is the reason why we are here—to exchange experiences, to seek the aid of our fellow members. In doing this our eagerness should be alloyed with a generous sprinkling of caution, because practically all worth while improvements in mechanics are a result of evolution, rather than revolution. When you find that startling results are claimed on behalf of some method or process you may safely assure yourself that it is not prudent to follow blindly; if you investigate before action you may save yourself many anxieties.

Unregulated enthusiasm, which gives rise to statements that cannot be substantiated in the light of evidence and reason, may be likened to uncontrolled fire and water. Such statements may do much harm if uncontrolled. Therefore, for the welfare of your association and for the benefit of posterity, we should endeavor to have those with excess enthusiasm on any particular subject, and those who have little, co-operate—in this way we can put both to useful work in just the same manner that we have caused fire and water to co-operate in furnishing us with steam pressure for the driving power of our locomotives and countless industries. The harm that may be done by the enthusiast is thereby minimized, the conservative has become constructive, each has contributed to the welfare of the other, and the sum of the world's useful knowledge and sound practice has been added to by their joint product. We then have a clear gain and no loss of anything useful, all brought about by co-operation, which is all that we are here for anyway.

* Assistant chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission. Abstract of paper presented at annual meeting of the Master Boiler Makers' Association, Chicago, September 16 and 17.

The Bureau of Locomotive Inspection, through the medium of the Locomotive Inspection Law, and in co-operation with this association, and other associations of railroad men, has done much to eliminate unsafe practices and practices of doubtful value from our chosen field of endeavor. We must keep everlastingly at it if we are to take our rightful place in the promotion of efficiency, economy, and safety upon our wonderful system of railroads. We find in our endeavor to enforce the Locomotive Inspection Law that most of the agencies concerned are very good co-operators—therefore we feel that there need be little of the element of compulsion present in our effort to enforce the law because we have very generally voluntary free and friendly co-operation. That is one of the main reasons why such good results have been obtained in our quest for greater safety.

I might visualize the Bureau of Locomotive Inspection as a central agency through which all co-operate for the promotion of safety of employes and travelers upon railroads—which is the object of the law. Prior to the enactment of the law practically all the large railroads had inspection and repair rules that were more or less adequate but these rules were generally considered as being merely expressions of desirable practices and little if any attempt was made to apply substantial repairs if any inconvenience would be caused thereby. As a consequence of this policy ineffectual or temporary repairs were often applied, or the locomotives were continued in use without making any repairs, and with known existing defects, until failures, frequently resulting in deaths or injuries, occurred. The framers of the law believed that an outside influence was needed to co-ordinate safety practices and safety standards—to get all concerned to work together in a uniform manner for the accomplishment of a specific object—the maintenance of locomotives in serviceable condition so that preventable failures with their resulting casualties would be reduced to the minimum.

When we compare locomotive performance today with that of only a few years ago, we cannot help but marvel at the progress that has been made. The accomplishments are familiar to you—reduction in engine failures, increased safety, increased train speeds, long locomotive runs, and reduction in fuel consumption per unit of work performed. None of these would have been possible in the absence of improved standards of maintenance to which your association has contributed its full share.

The relative improvement in safety of locomotive boilers and appurtenances in the past fiscal year as compared with the first year in which the Boiler Inspection Act was effective is shown in the following table.

Boiler and its appurtenances only	Year ended June 30 1936	1912
Number of accidents	74	856
Percent decrease	91	
Number of persons killed	10	91
Percent decrease	89	
Number of persons injured	79	1005
Percent decrease	92	

It will be noted that in the fiscal year just closed that there was a decrease of 91 percent in the number of accidents, a decrease of 89 percent in the number of persons killed, and a decrease of 92 percent in the number of persons injured as compared with the first year in which the Act was effective.

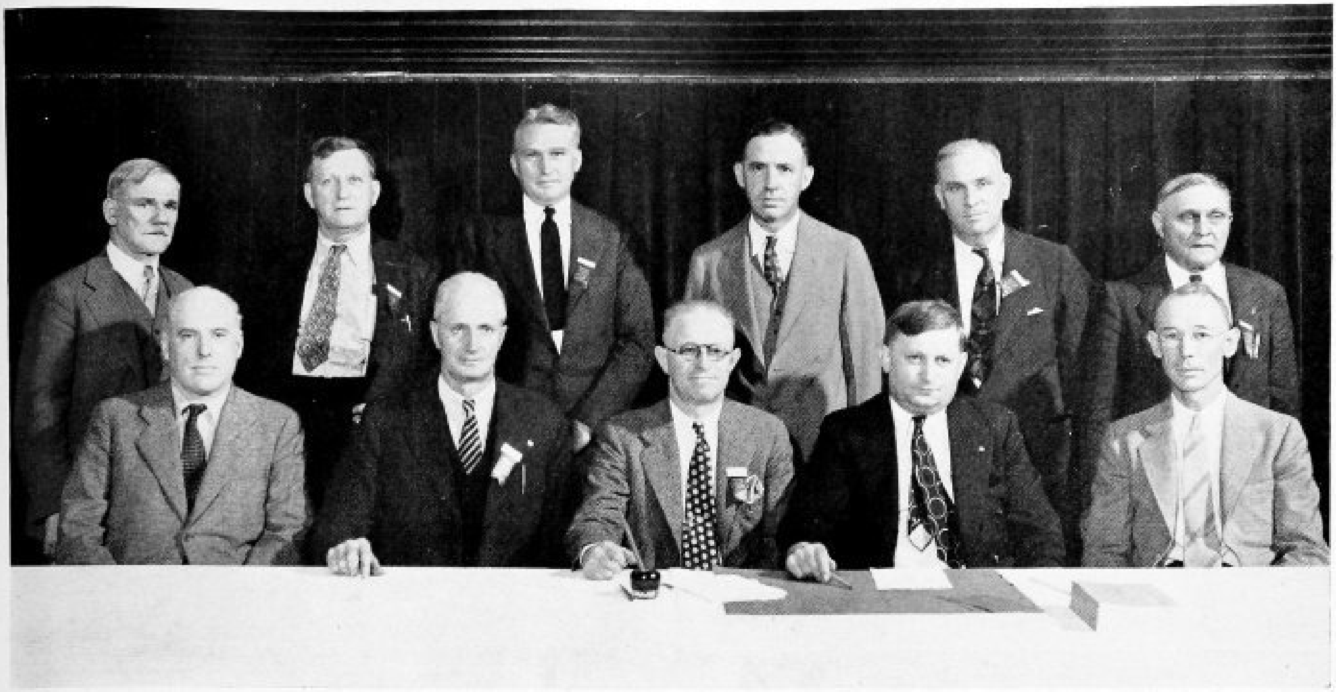
The machinery accidents since 1917 have been decreased 40 percent, the number of persons killed 30 percent, and the number injured 49 percent.

The records reveal only a part of what has been accomplished in the matter of increased safety as the statistics do not include the reduction in killed and injured, which is large but not directly determinable, caused by practical elimination of steam leaks that obscure the view of the enginemen. Prior to enactment of the law it was not uncommon for locomotives to be used throughout the winter months with steam leaking from the boiler and its connections to such extent that the view of the enginemen was entirely obscured. This practice caused many collisions, derailments, and other accidents resulting in deaths and injuries to employes and others because of lack of visibility. Likewise the statistics do not take into consideration the savings in life and injury brought about by reduction in collisions caused by moving trains striking trains stalled because of engine failures. Neither do the statistics take into consideration the fatal and less serious illnesses of those compelled to ride in cabs the interior of which was often continuously dripping wet from steam leaks from loose and broken staybolts, seams, joints, and valve packing, nor accidents that may have been caused indirectly by such illnesses.

Among other things, we have learned that engine failures with their consequent casualties are often caused primarily by small defects, which, within themselves, may by some be considered minor. These minor defects frequently grow into big ones, and sometimes in an incredibly short time. Timely workmanlike repairs will prevent the development of major defects. I emphasize workmanlike repairs because we frequently find the same defects repeatedly reported on the daily inspection reports, together with evidence that attempts had been made to apply repairs each time reported. This should be ample warning that the methods of repair followed were not effective, that progress was not being made in eliminating or alleviating these defects, and that time and money was being wasted and safety impaired. Master boiler makers who want to improve the service and reduce costs, and they all do, will find a fertile field in this direction.

In conclusion it might be well to mention that many of you now have the additional duty of supervising the inspection, testing, and repairing of steam and hot water heating boilers mounted on equipment propelled by power other than steam. In order to remove any tendency there may be to minimize the importance of proper inspection, testing, and repairing these boilers, many of which are of types often installed in coaches and only of sufficient size to heat the unit in which they are mounted, I would call attention to the fact that the railroads of the United States would have completed the calendar year 1935 without killing any passenger while riding in a passenger train had it not been for the explosion of one of these heaters in a coach. This particular accident resulted in the death of one passenger and the serious injury of another. Early in this year an explosion of a similar boiler occurred in a motor car train in which five persons were injured.

Because of the necessity of supplying an ample volume of steam at considerable pressure to the rear of long trains for heating purposes and the use of steam in connection with air-cooling equipment, there is a tendency toward increase in the pressure of steam heating boilers used in certain services, in some instances comparable to the pressure carried in the boilers of conventional steam locomotives. Some of these boilers are of the watertube type, with forced, rather than natural, circulation. Use of watertube type high-pressure forced circulation boilers for some steam-driven equipment is also in sight. Maintenance of these boilers may present problems not hitherto encountered.



Official Group at the Twenty-Third Annual Meeting of the Master Boiler Makers' Association

(Standing, left to right) M. V. Milton (president-elect), C. W. Buffington, M. A. Foss, I. J. Pool, J. L. Callahan (chairman of the executive board), C. J. Klein. (Seated, left to right) John B. Brown (assistant chief inspector, Bureau of Locomotive Inspection), guest speaker; F. T. Litz, O. H. Kurlfinke (president), A. F. Stiglmeier (secretary), C. A. Harper.

Master Boiler Makers' Business Meeting

The twenty-third annual meeting of the Master Boiler Makers' Association convened at the Hotel Sherman, Chicago, on September 16, with the principal objective of reorganizing the association in a manner that in the future will work for the greatest possible efficiency.

Extensive changes were made in the by-laws which were designed to modernize completely the official organization of the association. In the future the unwieldy system of vice-presidential offices advancing to the presidency almost automatically has been discarded. The association will now be headed by a president who will have had experience on the executive board to make him eligible for election. The vice-president will be elected by the executive board from its membership and he will act as the chairman of the board. He must also have had one year's experience on that board. The board itself will consist of nine members, three being elected each year for a term of three years. The offices of secretary and treasurer have been combined with duties specified in the revised by-laws. Many other articles were revised to bring the functions of the association up to date on the basis of business meetings which now take the place of conventions. The work of revising the by-laws was done by a committee consisting of Myron C. France, general boiler inspector, Chicago, St. Paul, Minneapolis & Omaha Railway, chairman; Kearn E. Fogerty, general boiler inspector, Chicago, Burlington & Quincy Railway; W. N. Moore, general boiler foreman, Pére Marquette, and L. W. Steeves, general boiler foreman, Chicago & Eastern Illinois Railroad.

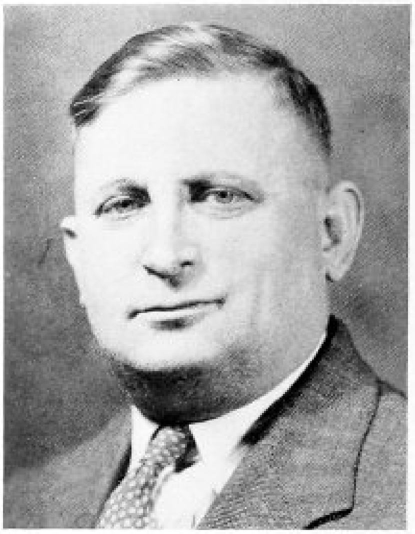
Nearly 175 members and guests were registered at this the second business meeting of the association, the first having been held in 1935 to replace the conventions of former days. President O. H. Kurlfinke, boiler engineer of the Southern Pacific, was in the chair throughout the two days of the meeting. The first order of business was the president's annual address, which was in part as follows:

Abstract of President's Address

As master boiler makers you have a part to play in the recovery of our railroads—there can be no doubt about that. Today you are assembled for the purpose of entering into the discussion of problems, the solution of which is of vital importance in the maintenance of locomotive boilers. Many difficulties of long standing will be analyzed and new ones will be presented for solution.

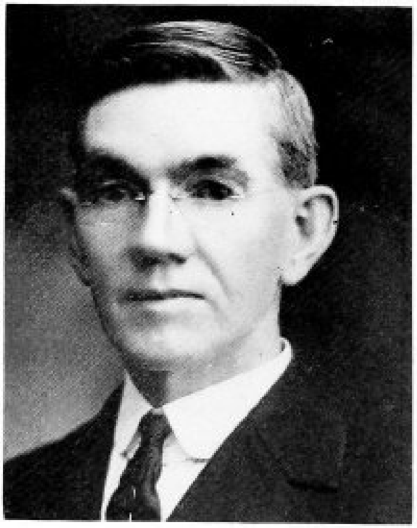
At meetings of this kind where men exchange their views freely many bothersome questions facing this industry will be cleared up. You will be enabled to gather valuable information on methods and procedure that, when you go home, you can put into practice; methods that have proved to be useful to others may be adapted and applied in the solution of your own problems. Every master boiler maker in attendance has come here with the intention of giving freely of his own ideas in the hope that he may also obtain suggestions which will prove to be valuable when he goes back to his shop. Those members, who were unable to attend, will also gain great benefit from the proceedings

M. V. Milton, president



A. F. Stiglmeier, secretary-treasurer

O. H. Kurlfinke, retiring president



W. H. Laughridge, retiring treasurer

when they are published after the meeting is over.

For these reasons it is extremely important that this association function efficiently. The future welfare of this branch of railroad maintenance work depends in a measure on what we, as members of this association, accomplish. It is necessary that each one of you take part whole-heartedly in the discussions, presenting your opinions and suggestions for the improvement of your chosen trade.

To the new members, who are now joining the association, we extend a hearty greeting and express the hope that they will all become active in our work.

Secretary Albert F. Stiglmeier, general boiler foreman, New York Central System, located at the West Albany shops, presented his report, followed by that of the treasurer, W. H. Laughridge, formerly general foreman boiler maker, Hocking Valley Railroad, Columbus, O. Both the financial and membership records of the association are in excellent condition.

Chairman of the executive board, J. L. Callahan, formerly general boiler inspector, Chicago Great Western Railroad, was called upon for a report of the board, which was in part as follows:

Report of Executive Board Chairman

I want to say at this time that the members of the executive board have acted in every way possible to facilitate the work of the organization. I wish to thank them for their co-operation and support. At the same time I wish to extend the good wishes of the executive board to our secretary. His efforts in trying to make our work easy have been very helpful. I think the secretary deserves a world of praise for the work that has been accomplished in the past year.

It has been our endeavor, as members of the board, in conjunction with the secretary and the president, to make this a very efficient organization. The business practices and policies that have been followed have been that of economy. Today our organization is the outstanding organization in the field of the so-called independent associations.

It has been my good fortune to work with the secretary and the president in formulating the various rules and laws that are going to come before this meeting for revision. It has been realized that our organization, like others is undergoing many changes. In the rules that will be presented for your approval some time during the day, there may be some radical changes. Some of you might not agree with them. I think if you will study these rules closely you will find that if adopted as presented it will be for the building up of this organization looking to the future. We hope that we will have a much bigger membership.

In conclusion, I wish to thank all the members for their co-operation and support and especially the members of the executive board.

Next in the order of business the committee on "Topics for the 1937 Meeting" presented its report. The committee consisted of George B. Usherwood, supervisor of boilers, New York Central, chairman; W. H. Keiler, locomotive inspector, Bureau of Locomotive Inspection, Omaha, Nebr.; E. H. Gilley, boiler foreman, Grand Trunk Western Railroad; G. E. Burkholtz, general boiler inspector, St. Louis-San Francisco Railway Company; P. W. Morgan, boiler foreman, Georgia & Florida Railroad.

The following subjects were approved for the 1937 meeting:

Topic No. 1.—Pitting and Corrosion on Locomotive Boilers and Tenders.

Topic No. 2.—Fusion Welding and Cutting as Used in the Fabrication of Boilers and Tenders.

Topic No. 3.—Proper Thickness of Front Tube Sheets.

Topic No. 4.—Improvements in Safe-Ending and Application of Flues and Tubes.

A large and active group took part in the twenty-third annual meeting of the Master Boiler Makers' Association

Topic No. 5.—Improvements to Prevent Cracking of Firebox Sheets out of Staybolt Holes.

Topic No. 6.—What is being done to Prevent Back Tube Sheets from Cracking in Radius of Flange and out of Tube Holes.

Topic No. 7.—Topics for the 1938 Meeting.

Topic No. 8.—Law.

The meeting then proceeded with the presentation and discussion of the paper "Proper Brick Arch Setting in Locomotive Fireboxes." This report was prepared by a committee consisting of E. E. Owens, general boiler inspector, Union Pacific Railroad, chairman; B. C. King, assistant general boiler inspector, Northern Pacific Railway; H. A. Bell, general boiler inspector, Chicago, Burlington & Quincy Railway, and C. F. Totterer, general boiler foreman, The Alton Railroad. This report and discussion appear on page 271 of this issue.

Next the paper "Boiler and Tender Pitting and Corrosion" was presented and opened for discussion. The report was prepared by a committee consisting of J. L. Callahan, formerly general boiler inspector, Chicago Great Western Railroad, chairman; A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul and Pacific Railroad, and J. P. Powers, system boiler foreman, Chicago North Western Railroad. The report appears on page 273.

The final paper at the Wednesday session which terminated at 5:00 p.m., was on the subject "Improvements in Locomotive Front Ends" prepared by a committee consisting of J. M. Stoner, supervisor of boilers, New York Central System, West, chairman; H. M. Cooper, district boiler inspector, Baltimore & Ohio Railroad; H. E. May, general boiler and locomotive inspector, Illinois Central Railroad, and G. E. Young, boiler foreman, Reading Railroad. This report and discussion appear on page 276.

Thursday Meeting, September 17

President Kurlfinke opened the Thursday session by introducing the principal speaker of the meeting—John B. Brown, assistant chief inspector of the Bureau of Locomotive Inspection of the Interstate Commerce Commission. Mr. Brown's address appears on page 265.

Following Mr. Brown, the president called upon Secretary Albert F. Stiglmeier for his annual address, which in part is as follows:

Annual Address of the Secretary

Looking back over the past year must convince even the most skeptical that the Master Boiler Makers' Association has reason to be cheerful and hopeful. All signs indicate that the coming year of 1936-1937 presents the bright promise of a prosperity already in sight. A quickening of activity is being felt throughout the United States and Canada; members all over the country are extremely optimistic. They all indicate a definite interest in association activities and pledge untiring support for the continuation of our association work.

The work of the officers and members this year has been excellent and success and future prosperity depend in a large measure upon the continuance of this spirit. For a successful continuance we must be railroad boosters first, last and all the while. We must again bring the people out of the air and from the highways back onto the rails, for it appears that the railroads now have a great opportunity for improving their service.

The railroads have gone into modernization with a will. They realize that before John Brown and his family will pay railroad fares that are nearly equal that for other modes of travel, there must be something on the trains to attract them. Hence, while it may seem foolish to some persons for train designers to bother with illuminated wheels, potted plants, fancy lights, modernistic furniture, bright color schemes and pleasant-sounding whistles, it is quite possible that such gadgets and improvements are the things which will make John Brown and his family buy tickets on the trains.

For years trains have been reasonably safe and reasonably efficient as regards schedules and running time, but to the American and Canadian traveler of 1936 these are not enough. Many a traveler is willing to ride in some other conveyance even if it is not as safe or not on schedule, if he can return home and tell his friends what a comfortable or thrilling ride he had.

Thus, while Americans and Canadians have appreciated the safety of trains and their on-time records, they have, in the opinion of many observers, been weaned away from rail travel by other carriers which have grasped the opportunity and have made showy and startling improvements.

It is apparent now that the railroads have seen enough of this and are going after the huge travel business in a big way—slowly at first, of course, because new trains cost money and in the end necessitate the abandonment of much equipment.

The recent high-speed streamlined locomotives and air-conditioned trains placed in operation on our leading railroads are examples of what is being done. It is possible that the nation is witnessing the dawn of a new and glorious era in rail travel, so it behooves each and every one of us always to be active and alert in doing everything possible to support the railroads. What you do in this respect you are doing for your association.

If your association is to continue, you must take an active part in the discussions of the papers being presented here at these meetings; your discussions will make your attendance worth while to your railroads.

Mr. Stiglmeier was also chairman of the committee reporting on the subject "Fusion Welding as Applied to Locomotive Boilers and Tenders." Immediately following his address he presented an abstract of this report which appears on page 279.

Other members of the committee on this subject included John A. Doarnberger, master boiler maker, Norfolk & Western Railroad; Sigurd Christopherson, supervisor of boiler inspection and maintenance, New York, New Haven & Hartford Railroad; H. H. Service, general boiler inspector, Atchison, Topeka & Santa Fe Railroad, and G. E. Stevens, boiler supervisor, Boston & Maine Railroad.

At the conclusion of his presentation, Mr. Stiglmeier introduced C. W. Obert, chairman of a special committee of the International Acetylene Association, which at the invitation of the Master Boiler Makers' Association, had prepared a paper on the subject "Applications of Oxy-Acetylene Welding and Cutting to Locomotive Boilers and Tenders." This paper appears on page 256.

At the conclusion of his presentation, Mr. Obert interjected one extremely important statement which follows:

"I wish to thank the association in behalf of the International Acetylene Association for this invitation to cooperate with you. I hope this paper may be of some slight benefit but if not, please give our association the opportunity to come back and work with you further. It is a large and growing subject and it seems to those of us who are actually in the work that we have not scratched the edge of the possibilities of these applications. Therefore, if there is anything that the association members can suggest in which the International Acetylene Association may be of help, it would be gratifying to that association to be apprised thereof so that we can render service in the future."

Two appendices which were not available for presentation in the meeting are also included in Mr. Obert's report as it appears in this issue.

Thursday Afternoon Session

At the opening of the Thursday afternoon session, Secretary Stiglmeier reported on memorials for members who have died during the past few years. Following this, the report on "Proper Thickness of Front Tube Sheets" was presented and discussed. The committee which prepared this paper consists of W. R. Hedeman, assistant mechanical engineer, Baltimore & Ohio Railroad; C. A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis Railroad; E. C. Umlauf, supervisor of boilers, Erie Railroad, and R. A. Pearson, general boiler inspector, Canadian Pacific Railway. The report appears on page 290.

The final paper "Proper Method of Applying all Types of Staybolts to all Types of Boilers" was read by a member of the committee—M. V. Milton, chief boiler inspector, Canadian National Railway. The remainder of the committee consists of L. C. Ruber, general foreman, boiler department, Baldwin Locomotive Works; G. M. Wilson, general boiler supervisor, American Locomotive Company, and C. W. Buffington, general master boiler maker, Chesapeake & Ohio Railroad. The report appears on page 287.

Chairman of the executive board, J. L. Callahan, then presented the names of members who have retired from active service and whom the board proposed for honorary membership as follows:

Honorary Members

Brown, A. E., (formerly) general boiler foreman, Louisville & Nashville R. R., South Louisville, Ky.

Browning, C. M., (formerly) general boiler foreman, Grand Trunk R. R., 56 Manchester Street, Battle Creek, Mich, No. 159.

Bruce, J. B., (formerly) foreman boiler maker, Frisco Lines, 2014 Central Avenue, Kansas City, Kansas. No. 38.

Cooke, J. E., (formerly) master boiler maker, Bessemer & Lake Erie R. R., 360 S. Main Street, Greenville, Pa. No. 287.

Cosgrove, P. E., (formerly) general foreman boiler maker, Elgin, Joliet & Eastern R. R., 103 Glenwood Avenue, Joliet, Ill. No. 124.

Crimmings, R. P., (formerly) district boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis R. R., Big Four, 1005 Wabash Avenue, Mattoon, Ill. No. 214.

Davey, J. J., (formerly) general boiler inspector, Northern Pacific R. R., 41 Aldrich Avenue, Minneapolis, Minn. No. 244.

Dittrich, A. C., (formerly) general boiler inspector, Soo Line, 1409 5th Street, N., Minneapolis, Minn. No. 203.

Emch, Nicholas, (formerly) boiler foreman, New York Central Railroad, West, 335 Ferris Avenue, Toledo, O. No. 147.

Guiry, M. J., (formerly) general foreman boiler maker, Northern Pacific R. R., 1672 Lincoln Avenue, St. Paul, Minn. No. 153.

Lucas, A. N., (formerly) district manager, Oxweld R. R. Service Company, 6402 Grand Avenue, Wauwatosa, Wis. No. 3.

Petzinger, C. F., (formerly) general boiler foreman, Central of Georgia, 742 Courtland Avenue, Macon, Ga.

Seley, C. A., (formerly) consulting engineer, Locomotive Firebox Company, Room 1908, 310 S. Michigan Avenue, Chicago, Ill. No. 68.

Sullivan, F. J., (formerly) boiler foreman, Illinois Central R. R., 537 E. Empire Street, Freeport, Ill. No. 160.

Wandberg, H. J., (formerly) traveling boiler inspector, Chicago, Milwaukee & St. Paul R. R., 3033 Bloomington Avenue, Minneapolis, Minn. No. 238.

Weis, August, (formerly) boiler foreman, Illinois Central R. R., 711 N. 9th Street, Fort Dodge, Ia., No. 243.

Zeigenbein, Emil F., (formerly) boiler foreman, Michigan Central R. R., 121 Gilbert Street, Jackson, Mich. No. 204.

Suitable action was taken confirming the recommendations of the board.

Mr. Callahan then proposed, in place of the gold badge formerly presented to retiring presidents of the association, that O. H. Kurlfinke be tendered a life membership in the association which was voted by acclamation.

(Continued on page 278)

Proper Setting of Brick Arches*

While the matter of proper setting of brick arches has been discussed and studied by individuals on various railroads, and by the manufacturers of arch brick for years, it has never been brought up as a subject in this association before. As a result, there are various opinions as to what constitutes a proper arch and most of us have been inclined to go along with the designs put before us by the different arch-brick manufacturers.

In making a study as to reasons for applying brick arches, we find that when railroads were first constructed in Great Britain, laws were enacted strictly prohibiting what is now known as the smoke nuisance, which meant that locomotives must be operated without emitting smoke to any extent. This forced railroad companies to use coke for fuel, but it was found in a few years that the use of coke was too expensive and it was then that different devices were tried in an effort to burn bituminous coal, which was very cheap at that time. One of the very first of these devices was the steam jet that induced air over the fire. This firebox device was patented by D. K. Clark.

The jets were not entirely satisfactory, although they had been accepted as the best smoke-preventing device developed up to that time, and it was Thomas Yarrow, locomotive superintendent of the Scottish Northeastern Railway, who conceived the idea of using a brick arch in a firebox in conjunction with the air jets and it was he who perfected the arch which to this day, if properly set and with proper induction of oxygen into the firebox, is the most effective method of preventing smoke emission.

In the past few years, the increased speeds that locomotives are called upon to make and the increased tonnage they are required to haul, have resulted in the locomotive boiler having to develop maximum efficiency and it behooves all of us to keep this locomotive boiler in condition and prepared to meet service demands at all times as economically as possible. There is no better way of accomplishing this economical performance than by carrying a well-proportioned arch to control the fire and thus obtain the benefit of all heat units possible with the least amount of damage to firebox sheets, bolts and flues.

In designing and building present-day locomotives, there is more attention given to construction of the firebox in order to accommodate a well-proportioned arch than in former years. Among the points to be considered are ample firebox volume, boiler throat design of sufficient depth to provide for ample firing clearance, which should not be less than 16 to 18 inches between grates and brick arch. The arch-supporting members should be located within the firebox to provide for a maximum length of arch, and still retain sufficient gas area at the end of the arch to be in proportion to the total gas area of flues and tubes.

The question is often asked "What should be the length of the brick arch?" Many locomotives operating with brick arches of insufficient length are not reaping the full benefits of the arch, due primarily to poorly constructed fireboxes and method or position of arch-supporting members.

Fireboxes in modern locomotives should be so designed as to carry an arch long enough so that the gas opening between the back end of the arch and crown sheet and the gas opening between the back end of the arch and fire-door sheet do not fall below the total gas area through the flues and tubes. The design should be worked out so that the opening above the arch is 115 percent of the flue and tube area and the same proportion holds between the back end of the arch end and door sheet. The number of courses carried in the arch depends on the length of the firebox, heights of arch-supporting members, type of grates, coal burning and front-end arrangement. We, the committee, would recommend a long low arch of sufficient length to set up a baffling effect on the fire and still maintain proper openings above and back of the arch.

Due to the present-day demands on locomotives, much of the efficiency is attained through the baffling effect of the brick arch, holding back and burning the fine particles of coal and making a better mixture of the gases that would otherwise escape into and through the flues. When too short an arch is used, the heavy pull on the fire will carry much of the fine coal now used in stokers over the arch without striking the fuel bed and shoot it against the crown sheet, staybolts, flue heads and flue sheet, with such force that damage is done to these portions of the firebox by the cinder-cutting action. By the use of long arches, properly applied, the force of the coal being delivered from the stoker is sufficient to throw it up under the arch, and since the action of the coal is forward, and the draft upward, this light coal under the arch must change its course of movement and in the small moment of time it takes for this action, it is burned in suspension and the light ash or cinder resulting is picked up by the draft. The heavier particles of coal light on the fire bed and are burned. Through this action of burning due to the long arch, the amount of charred particles of coal carried over the arch is a great deal lessened. On some railroads it has reduced cinder cutting of crown sheet heads, flue beads and sheets fully 30 percent.

The use of arches, opened and closed, at the throat sheet, depends largely on the kinds of coal burned, but generally speaking, the greatest efficiency will be obtained with the closed arch that is run down tight to the throat or flue sheet and uses no spacer brick between courses. We find where arches are properly proportioned and set, combustion is improved to some extent, fire particles are burned to a light ash or cinder and are carried out by the draft and do not remain in the combustion chamber or form clinkers over flues.

We believe wherever possible curvature of arch tubes should be restricted to that portion of the tube which is free of the arch, as arches are more stable and will remain in place better when lying on a straight smooth surface. We would recommend that sufficient arch tubes be so applied that the spacing would accommodate 18-inch brick as a maximum and it is good practice to space tubes to carry 14-inch and 16-inch brick or 16-inch and 18-inch brick.

In our opinion, the best method developed to carry

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* The committee which submitted this report here abstracted is composed of the following members: E. E. Owens, general boiler inspector, Union Pacific Railroad, chairman; B. G. King, assistant general boiler inspector, Northern Pacific Railroad; H. A. Bell, general boiler inspector, Chicago, Burlington & Quincy Railroad; C. F. Totterer, general boiler foreman, Alton Railroad.

the arches is the use of arch tubes of 3-inch, 3½-inch and 4-inch diameter, depending on the length of the firebox. In order to overcome wearing on side sheets or on the side sheets between side patterns, we recommend the welding of trunnions to the sheet where the brick-work rests. In narrow fireboxes of the OG type, we recommend that studs be welded to the side sheets for the arch brick to rest upon and wherever possible, center brick be supported by tubes. The use of the hinge type brick over long spans should be avoided, although this type of construction can be used successfully up to 24-inch patterns.

It is our recommendation that arches be removed entirely at the inspection periods and that old brick, damaged by handling when taking down, by deterioration, or burning, be replaced. Care should be taken in handling brick to save as many as possible and all new supplies of brick should be kept stored in a dry place, carefully piled, to avoid any possibility of their falling over and causing breakage.

While we have made quite a lengthy report on this subject, we, the committee, believe the subject to be of vast importance and one of the most vital factors to be considered at this time, as the demands put upon locomotive boilers are such as to require the utmost of efficiency, not only from a fuel-conservation point of view, but to fit them to produce sufficient energy to meet present-day railroad requirements and we welcome any discussion that will lead to improved performance by the proper setting of brick arches in fireboxes.

Discussion

K. E. Fogerty (Chicago, Burlington & Quincy): On our S-4 passenger locomotives, operating at 250 pounds pressure, we had difficulty with cinder cutting.

In discussing different type arches with the arch companies, we decided to drop the arch tubes 8 inches at the back end, which would allow twelve bricks in the center, eleven on each side and down to nine on the side. I want to say that at the present time we are getting wonderful results and preventing cinder cutting to a considerable extent.

L. R. Hoose (Baltimore & Ohio): We have a bad condition on the locomotives which we call our 5000's. We have four rows of arch tubes in the firebox. We have arch brick in the center, arch brick in the intermediate row, and at the side sheets. In the center and intermediate rows we used eight rows of brick with only seven rows of brick on the sides.

At our eastern line terminal we found that we had considerable cinder cutting of flues, particularly on the sides. Going back and getting our arch brick arrangement out, we found that the later design called for eight rows of brick all the way across. I might say that the cinder cutting flues on that particular class of locomotive is at a minimum.

It is my contention that with the lesser number of brick near the side sheet there is an extra volume of gases that must follow the path of least resistance; in my opinion that causes cinder cutting flues.

The gentleman who spoke before said he had twelve in the center and it tapered down to eleven and nine. I think if you maintain the same number of brick on the arch all the way across, your cinder cutting flues will be at a minimum, if you have the same number all the way across.

I would like to ask representatives of the different railroads the relative merits of a sealed and an open arch. On the Baltimore & Ohio Railroad, we have used the sealed arch on most of the districts but on one district, the Buffalo Division, which was originally part of the B. R. & P. Railroad, they have the open arch and they use the F-5 spacer brick.

E. E. Owens (Union Pacific): I possibly have fought cinder cutting longer than any man in the room; in fact, I was the one who first called attention to it in this country. In 1924 we had some engines built. They made 150,000 miles without any cinder cutting and I never even welded the flues. I obtained very satisfactory performance by carrying six brick in the arch.

In 1926 they started to get speed out of these engines. They ran them more than forty-five miles an hour. The result was that the cinders drove against the flue sheet and acted as a sand blast, grinding the flues off and blasting the sheet down. At 65,000 miles it was necessary to remove the flues. We then went to a longer arch. Next we dropped the arch tube down eight and three-quarters inches, which allowed us to put in eight or nine rows of brick.

I got 117,000 miles out of the engine before I had to resort to welding over the beads. When I lengthened the arch, I did away with the accumulation of cinders up in the combustion chamber. As the speaker said, sometimes one has to get in there with a pick and pick it out. This filled up over my flues, and my tubes were leaking when I had a short arch. After installing the long arch, the combustion chamber remains absolutely clean.

When I had a short arch on those engines, after they were operating two years, I took out two and three hundred crown stays because their heads were shaved off. In the two years since I have lowered the arches and put in the long arch, I haven't taken out a crown stay on account of cinder cutting.

K. E. Fogerty (Chicago, Burlington & Quincy): I have tried about six locomotives without the sealed arch, with a five-inch spacer brick in front, and I think I am getting wonderful results without the arch tubes being dropped. I want that thoroughly understood.

Now as far as the brick is concerned, when I said we dropped the tube, we went to a 12-inch brick. When it comes to a standard stoker, it doesn't make a particle of difference, absolutely! Where you have the duplex it doesn't make a particle of difference,—absolutely none. Whether you have the standard Master Mechanic's front end or what other front end arrangement you have makes no difference. Take a nozzle tip of six and seven-eighths or seven and a half or whatever it may be, with a twenty-five or a twenty-seven inch cylinder, there is no difference as far as cinder cutting is concerned.

The Eastern people do not have to contend with a lignite coal, which requires engines to use a front end netting, and they don't experience that trouble.

E. E. Owens: I have experimented by putting a spacer block between every brick and I found I didn't make any showing. After 65,000 miles we would have to double-weld the flues. After 75,000 miles I would have to take them out. When I put the arch down tight against the flue sheet and made a furnace out of that firebox, which it is intended to be, I get better results. The lowering of the arch tube was done for the purpose of getting 115 percent gas area above the arch.

H. H. Service (Santa Fe): I think Mr. Fogerty has struck upon a pretty good point there. I want to illustrate two different conditions on the same class of power, operating in two different territories, with two different kinds of coal. On the Missouri and Illinois Division our arches have a spacer and they come up six and seven rows. We tried seven rows without spacers and the engines didn't steam. We put the spacer in and raised the arch that much, and the engines steam and there is no cinder cutting on the sides or anywhere in the firebox.

However, the entire flue area became covered up with a honeycomb formation, caused by that type of coal,—all the way from one to 6 inches thick,—60 percent and 70 percent of the entire area was stopped up solid. But there was no cinder cutting.

With the same type of power, operating with a lighter coal over on the Albuquerque Division, with the same sized fireboxes, the same kind of an arch except the spacer not involved, we had cinder cutting of the radial stays and on the top of the flue sheet on the far side. We dropped two rows of brick and the cinder cutting let up.

However, we increased the fuel performance to such an extent that it would pay us to put the brick back in place again and pay for what cinder cutting action was taking place. Therefore, it resolves right down to two different types of coal.

G. E. Stevens (Boston & Maine): I want to ask the speaker if that included all the tubes in the tube sheet or just part of them that were cinder cut.

E. E. Owens: Just part of them. My trouble starts about 10 inches below the flue sheet and runs down to 36 inches over a small area.

G. E. Stevens: On our power there are fourteen tubes on the outside row that give trouble with cinder cutting, and we are using a shield on the lower part. It is very easy to remove. We simply renew the shield when it becomes cinder cut.

Frank Yochem (Missouri Pacific): We have a lot of coal-burning engines on the Missouri Pacific Railroad and the greatest trouble we have is that of the arches in our big power slagging and running and reducing in thickness in seven and eight hundred miles. It is necessary to renew the center row of brick on account of the deterioration.

We are conducting a test at the present time with bricks that are 5 inches thick and 5 inches wide to see if we can get more life out of our arches than we are getting. We have no trouble except cinder cutting of the side walls in the smoke box. We are having a lot of trouble with that now.

But on our old style Master Mechanic's front end, there is no cinder cutting in the smoke boxes and of course none in our fireboxes.

Our arches are five, six and seven rows deep, all depending upon the length of the fireboxes. We experimented with the sealed arch. We had no success whatever. It was the bottom flues that were stopping up all the time and giving us trouble, so we use a 5-inch spacer brick on our combustion chamber engines as well as on our straight flue sheet engines, in order that the accumulation of cinders on top of the arch will drop down and not stop up the bottom flues.

S. Christopherson (New York, New Haven & Hartford): We have about twenty Mountain type locomotives. They are all equipped with siphons and when we got them we had considerable cinder cutting on the two outside rows and also on the top flues. Now all those flues are open. Some are 3½, some 2¼-inch tubes. In order to overcome cutting on the former, we reduced the opening in the front by using a thimble. In other words, we reduced it to practically 2 inches, which has overcome all the cinder cutting.

We were using eleven gage. We took the safe end and increased it to ten and we haven't had any more cinder cutting. We are using a straight arch, seven rows, with closed brick. We always had good success with it and all our engines are equipped with siphons.

B. C. King (Northern Pacific): We have had considerable cinder cutting and it was mostly confined to the small area fireboxes. We have large fireboxes—114 inches by 264 inches—which do not show any cinder cutting.

Another method that we have tried of late and which is working out successfully is by leveling the grates in the firebox, lowering the back end and raising the front end. We have them so they only clear the arch tubes by 4½ inches in some cases.

M. V. Milton (Canadian National): I have nothing to report, really, on cinder cutting in the fireboxes as far as Canada is concerned. In the front end we have, as you all have, cinder cutting. How are we going to get rid of cinder cutting when today our locomotives are forced in many cases to burn a greater volume of coal per square foot of grate area then they were actually built to burn? They were built to burn only to an efficient point.

Nothing has been said of the analysis of the coal used. But let me tell you that that analysis of the coal is one of the greatest factors you have in your cinder cutting today. Many of the coals used contain what is practically nothing more or less than carborundum.

C. M. Klink (Chicago, Milwaukee, St. Paul & Pacific): We also have had trouble with cinder cutting on our F-6 power. These fireboxes are equipped with three siphons,—one in the combustion chamber and two in the firebox. The cutting takes place in both top corners of the flue sheet.

Some time ago we went to thimbles. We are still running them with thimbles on both sides at the top of the back flue sheet. We also found there was cutting of the radial stays and the backs of the siphons. We have to build them up. But this is only on engines running from Minneapolis to Harleytown. These engines are also cutting all their front ends and none of these engines has a Master Mechanic's front end. They are all equipped with Cyclone or some other baffle front end.

We tried the brick arches. We ran engines with sealed brick arches up to about two months ago. Then we decided we would open up the brick arches at the throat sheet, leaving a spacer in of about 5 or 6 inches. The results have yet to be determined.

J. A. Doarnberger (Norfolk & Western): There is no question but what this is a live subject; it is very interesting.

I heartily agree with Mr. Milton that he is on the right line. Cinder cutting has been going on for some time in the smokebox fronts. We have had that. It cuts out smokebox rings and smokebox sheets. The cutting action in the firebox is not confined to any one point. We will find it sometimes among the flues on the right hand side, sometimes on the left hand side, sometimes up at the top. You talk about the siphons. Sometimes we will find them all sloughing off along the top.

I suppose a lot of you have what is known as the Gaines' wall in there. I haven't heard anybody say anything about the Gaines wall, the maintenance of it, its importance as to upkeep. We have in that wall, if I am right, what is known as the 466, —a hollow brick arch—with probably four or five intake combustion tubes.

For the benefit of the association I might say that we have tried out a solid brick wall, omitting the combustion tubes, using a brick that is 2½ inches thick, 5½ inches wide and 13 inches long. We have more than trebled the life from ninety days up to almost a year.

E. E. Owens: We have a Gaines arch. When we ran the high arch, we had to renew this Gaines arch down to the first row every month. After lowering the arch, we ran that wall up to the cap brick indefinitely. I don't know whether it runs six months or nine months, but the cap brick has to be renewed every month.

Boiler and tender

Pitting and Corrosion*

At the last business meeting of this association, it was recommended that the committee continue to study corrosion and co-operate with and assist members of the Water Service Section of the A. A. R. and the various water treatment engineers in their efforts.

During the past year members of this committee have been invited to and have attended meetings of the Water Service Section in which subjects relating to water treatment, 30-day washout periods, boiler design, construction and maintenance were discussed.

At the present time extensive chemical research is being conducted in laboratory experimental boilers to determine the cause of pitting and corrosion of boiler plates and tubes, due to water. Many forms of corrosion, as a result of such research, have been found and corrected by application of inhibitors to the feed water.

Research on embrittlement of boiler plate is being followed closely by members of the Water Service Section. This research, while not completed, has brought forth information heretofore not considered. Such factors as riveting pressures, purity and uniformity of rivet and plate metal are now considered as possible causes of caustic embrittlement. Results learned from this research will undoubtedly be applied to boiler construction and water treatment as found warranted. As master boiler makers we are not expected to become familiar with all of the technical features of such research, but we can assist as an organization by discussing the problems that confront us and passing them

* Report presented by committee composed of the following members: J. L. Callahan, general boiler inspector, Chicago Great Western Railroad Company, chairman; A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific Railroad Company; J. P. Powers, system general boiler foreman, Chicago & North Western Railroad.

on to those who are studying such problems.

In defining corrosion of boiler metal, the members of the Water Service Section in a report having to do with extending washouts said: "It is a complicated phenomenon caused by any one of a number of water conditions, metal characteristics, stresses in boiler assembly or a combination of two or more of these conditions. The definite cause in any one instance is frequently difficult to determine. Correct application of chemicals to natural waters usually carries the best antidote for corrosion which is caused by water conditions and chemical treatment of water to prevent scale formation also prevents most corrosion of boiler metal."

Stresses set up in boiler assembly result in breaks in the metal structure that after a period of service may form grooving that is often charged to a water condition. New boilers of the modern type with high pressures undergo shell and firebox movements. In the first few years of service we encounter a "settling down" of the sheets and the stresses especially those due to the rapid raising and lowering of pressures result in fatigued metal that eventually develops into grooving, pitting and cracked plate. This condition is purely mechanical and can only be overcome by a study of the stresses and through high grade workmanship. It is believed that stress relieving through normalizing as done in the welding industry will in time be adapted in modern boiler construction.

Where water conditions are properly controlled by water treatment and through use of systematic blow-off equipment, washouts can be extended for the full 30-day period, uniform boiler temperatures can be maintained that will assist in eliminating much of the expansion and contraction stresses now encountered in frequent boiler washing. It is urged that serious consideration be given to this one problem which undoubtedly is the cause of much firebox leakage and responsible for the costly repairs necessary to modern high-pressure boilers.

During the past year attention has been given to grooving or ring worming of tubes on the water side, inside of the front tube sheet. It has been found that this condition generally exists in all large boilers having a tube length of twenty feet or over. In a survey from twenty railroads, two reported that their problem was due to water conditions and was corrected by chemicals.

The other railroads that have experienced this trouble have arrested the condition or control it by: Applying new tubes in the area affected; counter boring the water side of the front tube sheet hole to give at least a ⅛-inch radius; shimming the tube snugly to the sheet to prevent stressing of the tube in the rolling process; application of rolls with proper bevel to prevent cutting of the tube and by inserting short nipples in the front end of the tube.

At one time extended copper ferrules were recommended, but tests conducted over a period of years developed that the problem was one of proper tube application, proper shimming of the tube in the hole and rollers with good bevel. Application of nipples has been tested and while found to extend the tube life, tube stoppage and loss of heating surface developed. It is now possible to purchase tubes of a heavier gage at the front end where it is felt additional metal will strengthen the tube against vibration and cutting on the front tube hole. The survey on grooving of tubes indicates that it is mechanical and can be overcome by close supervision and proper application.

Corrosion as a result of stress is mechanical and warrants the study of the boiler department. Corrosion as a result of water requires the study of a chemist. As master boiler makers we must be alert to the many changes that take place and be prepared to assist the chemists and the water service engineers in directing attention to the problems as they arise. It is only through co-operation that we can hope to secure longer boiler life and reduce boiler repair costs.

Discussion

John P. Powers (Chicago & North Western): During the last twelve years a vast improvement in locomotive boiler performance on the Chicago and North Western has been observed. From available information obtained from other railroads, the same gratifying results have been noted, especially in districts where boiler failures were previously quite common.

Although operating conditions are now very close to ideal with reference to leaking fireboxes and flues, the problem of pitting and corrosion in some districts is still one of some concern. It is gratifying to note that there has been a decided improvement in the control of pitting and corrosion and one of the beneficial factors in obtaining these results has been the assignment of locomotives to longer runs.

We had three distinct districts between Chicago and Omaha. One from here to the Mississippi River where we had no pitting, the water was good; from Clinton to Boone we had some pitting; and from Boone to Council Bluffs we had a very severe pitting condition. In fact, the flues lasted from fourteen to sixteen months only, when they had to be taken out.

Now we operate from Chicago to Omaha and have no pitting whatever. We get a full period of four years out of the flues on these long runs.

Operating a locomotive over two or more of these districts tends to offset the possibility of the water causing trouble from pitting. Owing to operating conditions, it is necessary to operate some locomotives in districts where the feed water is responsible for corrosion and it is in the boilers of such locomotives that the greater percentage of corrosion is observed.

From actual results obtained in boiler economy, it is apparent that longer locomotive runs should be encouraged not only from results obtained in the elimination of pitting and corrosion but also due to the possibility of accumulating greater locomotive miles with less strain on the boilers due to knocking fires, firing up, expansion and contraction of boiler metal,—all of which aggravates corrosion trouble when present.

It has been proved beyond question of a doubt that locomotive boilers are operated most efficiently when assigned to longer locomotive runs. A number of experimental tests have been under way during the past several years consisting of electro-chemical methods as well as protective coatings as aids in the elimination of corrosion. It has been found that the electro-chemical process has retarded pitting on several locomotives, especially when assigned to switching service.

I would just like to say for the electro-chemical process, we equipped six locomotives in 1929, and out of those six locomotives we have gotten the full flue period and on four of them we have had additional time granted. It was not possible to operate them all the time in pitting districts due to operating conditions which require change of power, but the results were very gratifying.

We have tested out protective coatings, especially in the boiler shell. Where these coatings were properly applied, we do not find it necessary to scale the boiler. We can just scrape it off readily.

The air hammer method for removing scale has undoubtedly done considerable damage to boiler shells in the past due to abrasions as a starting point for corrosion.

Open feed-water heaters have shown very little results in retarding corrosion. Eliminating oxygen from feed water is undoubtedly beneficial but the present open type feed-water heater cannot accomplish this result due to the fact that it is necessary from time to time to operate injectors while locomotives are in service.

It has been found, however, on stationary boilers that the open type feed-water heater will accomplish excellent results. A practical and efficient de-aerator applied to locomotive boilers would undoubtedly eliminate considerable of the present pitting.

Another important factor in the elimination of boiler metal corrosion is the proper storage of boiler material. These materials, if they are stored in the open without protection from the elements, should in all cases be coated with paint or oil at intervals frequent enough to eliminate the start of this trouble.

This material should, furthermore, be used as soon as possible on receipt from the steel manufacturers. For this reason too large a stock of such material should not be carried without the material being properly protected. Where safe ends are made up of stock boiler tubing, only the longest length should be carried, thereby cutting down the stock required for the various lengths of locomotive boilers.

Embrittlement of boiler plates might be placed in the same class as pitting and corrosion. The cause of this trouble has never satisfactorily been determined other than that stress and strain, combined with feed water lacking in certain elements, has been noted where such trouble occurs.

Apparently the later types of boilers are more subject to this trouble than the smaller boilers of earlier locomotive operation. Definite characteristics identify this type of boiler cracking and experience has led us to look for certain identifying defects such as broken rivet heads on the outside of the boiler shell.

This type of cracking can be traced to locomotives working or having previously worked in definite districts. Antidote in the form of tannin extract is now added to the feed water in these districts with apparently good results, although it is not definitely known that the trouble has been entirely stopped.

At the present time the Joint Research Committee on Boiler Feed Water Studies, through its sub-committee and acting under the supervision of the American Society of Mechanical Engineers, is directing an investigation at the United States Bureau of Mines Station at New Brunswick, N. J.

There is a considerable difference of opinion between the various water engineers and the boiler makers at the present time as to the cause of this defect. Personally, I am quite well satisfied that it is a combination between chemical reaction in the water and strains set up in riveted seams. You cannot build a boiler with riveted seams without setting up some strain.

I might add that all of these failures which have occurred have been traced to a certain definite district. That is the reason why we have concluded it is the action between the water and the strain on the riveted seams.

J. L. Callahan (formerly Chicago & North Western): Corrosion has always been more or less of a problem with the boiler maker.

The question of ring worming of flues is a big one. We find that practically every railroad has encountered it and we find, too, that no two master boiler makers agree as to just what is happening. I would like to call on Mr. Milton. He has had experience in this connection and is supposed to have corrected it.

M. V. Milton (Canadian National): We in Canada, like all of you, have good and bad waters, good and poor engineers, too. Our system over there has been and I believe will always be internal treatment. I have had a lot of experience in trying to educate the boiler staff. My experience has been that we should really teach even the washout man that there is something in water treatment.

I note the report says that where water conditions are properly controlled by water treatment, through the use of systematic blow-off equipment, washouts can be extended for the full thirty-day period. Now increasing the washout to thirty days cannot be done unless you keep the boiler tight for thirty days. We all know that. In washing the boiler out at the end of thirty days, in my opinion, should be by a method where sufficient time is given to do a thorough job. The longer we can keep a boiler under steam, the less stresses are set up.

Frank Yochem (Missouri Pacific): On the Missouri Pacific Railroad in different sections and states we have a great deal of pitting. In some cases we would get just about two years out of tubes when it was necessary to renew them and scrap the set we had taken out because of the pitting condition.

To try to eliminate the condition we have put a blow-off cock in the belly of the first course of the boiler. We have standard instructions that at the terminal on the outbound move we blow a blast of water out through the belly valve cock located in the first course of the boiler to eliminate the sludge and try to get away from the pitting at the front flue sheet.

Now we have gone to a thirty-day period between washouts. We did this two years ago. We made some tests. We located blow-off cocks in the right and left side of our casing sheets near the front mud ring corners right above the mud ring. We have issued standard instructions. The practice has been in existence for two years now. The train crew will use the blow-off cock, alternating from the right to the left side from four to six and eight times an hour, each blow to be of a duration of five seconds.

Frank Longo (Southern Pacific): From 1913 until 1925 we replaced 2127 fireboxes. In the period from 1925 to 1935 we cut that down to 997 fireboxes. That was due to the welding in of patches and, most of all, our water treatment.

We have a treatment called Zeolite. I imagine the majority of you men have heard about it. Our engines were washed out every trip before we had Zeolite. We put the first treatment into our stationary boiler plant at Los Angeles, and at that plant we tested a switch engine that worked in the yard. That switch engine was washed out every other day and it was leaking. We picked out a bad one, and we had nothing but continual trouble with that switch engine before we put Zeolite water into it. After we applied Zeolite water that same switch engine ran the full thirty days. Of course that change was not made in a week; it took time to take the scale out of the boiler.

Before we had our treated water on our Coast Division engines, we renewed staybolts every ninety days and flues every six months and we renewed radials very frequently. We couldn't get eighteen months out of a set of radials. Since Zeolite-treated water has come in, we very seldom ever have to go into a firebox and take care of a leak.

H. H. Service (Santa Fe): This is a very highly controversial subject and although there have been improvements made, it is very difficult to lay your finger on just one thing that has brought about some of the improvements.

You heard one man talk about Zeolite treatment of the water. Well, we just repaired a boiler operating in a district using Zeolite water. You hear other men talk about compounds of various kind, such as sodium aluminate. They all have their place in the right kind of water. There are various kinds of water. We cannot lose sight of that fact.

Mr. Powers talked about extended runs helping. There is no question about it. We have increased our mileage between flue settings. Last year's average on flue settings was a 125,000 miles per set. The year before it was 113,000 miles. The number of flues scrapped on account of pitting has reduced somewhere in the neighborhood of 7 percent. That is both superheaters and small flues.

So, extended runs, keeping your locomotive fire box under equal temperatures, minimizing the stresses, or reducing the rapid change of stresses from a cold to an extremely hot temperature, all have an effect. We have found those things to be true. Nevertheless, we do have some pitting in certain districts.

H. J. Peters (Pennsylvania) We had several cases of ring worming of flues years ago. We are using ½-inch front flue sheets in all of our engines. With a ⅞-inch copper ferrule in the front flue sheet grooving is absolutely stopped. We have had that demonstrated over a period of five years.

R. C. Bardwell (Chesapeake & Ohio): You men are keeping abreast of the situation and I believe that most of you are fully informed on most of the details of water treatment.

We have had the pleasure of having Mr. Callahan attend some of our water service meetings and it is only by this kind of co-operation, in my opinion, that we are going to make much advancement in the future. It will take the co-operation of both the boiler department and the water department if improvement is to be expected.

When it comes to scale removal and stopping leaking conditions caused by scaly deposits in boilers, there is really not much excuse for that kind of trouble any more because remedies are so well known and are available to anybody who wishes to use them.

However, in connection with pitting, that is a different matter. There are more angles to the problem and it is a problem that takes co-operation to get to the bottom.

On the Chesapeake & Ohio Railroad we will remove annually between six and seven million pounds of scale in our water-softening plants that formerly used to go into boilers.

I am glad to hear the gentleman from the Southern Pacific get up and say that they are getting such fine results with Zeolite plants. Unfortunately we have had an experience which is not so favorable as that which he describes. It seems as if there is just a little danger in keeping the boilers too clean.

The subject of this discussion is "Pitting and Corrosion," and that is exactly what takes place when we keep the boilers a little bit too clean. We do not try to eliminate all the scale from our boilers. In fact, we prefer to see a white protective coating in them, and in most cases we try to get that. If we don't our general boiler inspector, Mr. Buffington, gets busy on the job and makes life unpleasant until the situation is corrected.

D. A. Steele (Railway Age): This is one association of the railroads of the many which I see in action throughout the year which appears to have withstood the rigors of regimentation most successfully and continues to reveal a determination to express its beliefs and retain its own opinions.

The progress of transportation demands more than ever before the accurate observation of phenomena such as that involved in corrosion; on the freedom of reporting those observations and opinions and the vigorous maintenance of a free interchange of experiences with the problem.

I want to express and emphasize and reiterate the very warm feeling I have for the boiler makers of the country, not only by reason of the essential place they occupy in the maintenance and operation of the motive power unit which the efficiency, the revenues and the safety of the entire railway business depends, but also upon that freedom with which they come here and, in the presence of representatives of conflicting viewpoints—perhaps representatives of manufacturers on the one hand and conflicting departmental viewpoints—will express their views and

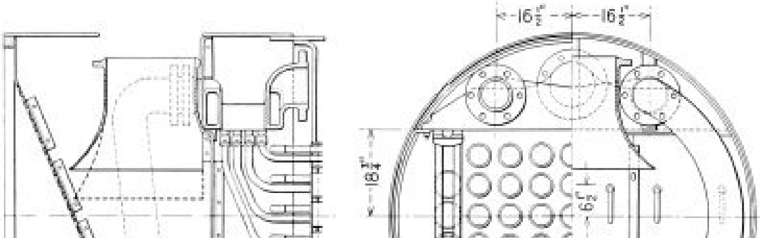
(*Continued on page 293*)

Recent improvements made in

Locomotive Front Ends*

The development and improvement in locomotive front ends has kept step with the progress of the locomotive in general. At the present time, while there are various types of experimental applications the generally accepted or standard application is known as the Master Mechanics or Association of American Railroads standard or some equivalent of this type front end.

The simplicity and economy of this type application has appealed to the mechanical forces down through the years and particularly since the advent of the superheater as frequent removals for repairs to the units and other work were necessary.



Figs. 1 and 2.—Master mechanic's front end

Figs. 1 and 2 show a good application of this type front end in detail, also Fig. 3 of their Goodfellow exhaust nozzle tip used in conjunction with this type application and from which excellent results are obtained.

In the application of front end equipment regardless of type there are certain fundamentals which must be observed if efficient performance is expected. The principal requirement is a smoke arch tight and free from air leaks so that it is not necessary to create excess forced draft to compensate for leaks at the smoke arch door, stack base, steam pipe housing, or unit leaks.

While different type locomotives and different fuel might call for various alterations and adjustments of the several units in the assembly, a fairly safe basis for efficient drafting is to use the open area of the flues less the superheater unit area if equipped with superheater as a 100 percent base and reduce this area to 65 percent at the adjustable deflecting plate in the front end.

In the event the locomotive is equipped with a brick arch, place the brick tight against the plate and leave provision at the top of the brick for 115 percent open area so no restriction will cause pulling or tearing up of the fire. The open area in the front end netting or spark arrester should also be 115 percent so there is an even flow of the gases and heat from the firebox to the stack and out to the atmosphere.

Referring back to the exhaust nozzle and its tip, it is important that the area is not reduced to a point where excessive back pressure is built up. Various railroads have their particular style of nozzle and in most cases have a bridge or other device for spreading or deflecting the exhaust steam so that the lift pipe or stack is filled completely and a good plan to work from is to use a ratio of the tip diameter to the cylinder of 1 to 4. While this is by no means a constant, it can be varied by bridging: a good application of a practical bridge is shown in the Illinois Central System's stream lined basket bridge.

In connection with coal burning locomotives it is necessary to provide an efficient spark-arrester. Various devices are used for this purpose such as a perforated plate and wire netting for the screen. The netting is the most popular and the one most generally used. It is applied in straight sections across the smoke arch, in circular and box form, located on the table plates and in some cases staggered in various shapes to get more area and to break up the sparks into smaller particles. Figs. Nos. 4, 5, 6 and 7 show the circular netting and the clatterbuck as applied by the New York Central System. This application will give 15 to 25 percent more open area than the conventional application.

There also are several patented devices used as spark arresters, the principal one being the Cyclone spark arrester as manufactured by the Locomotive Firebox

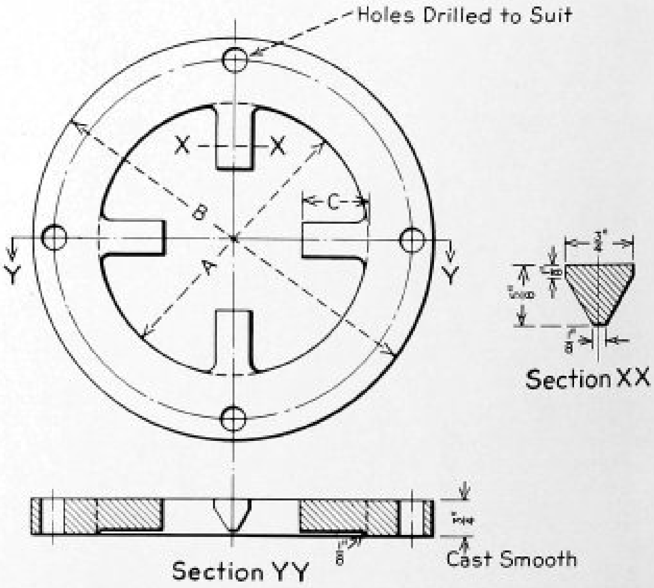
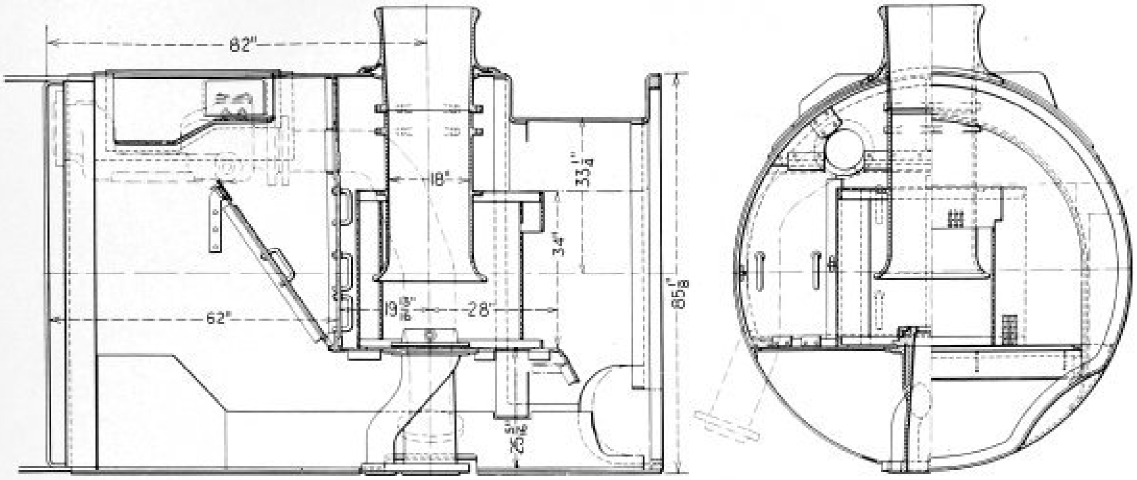
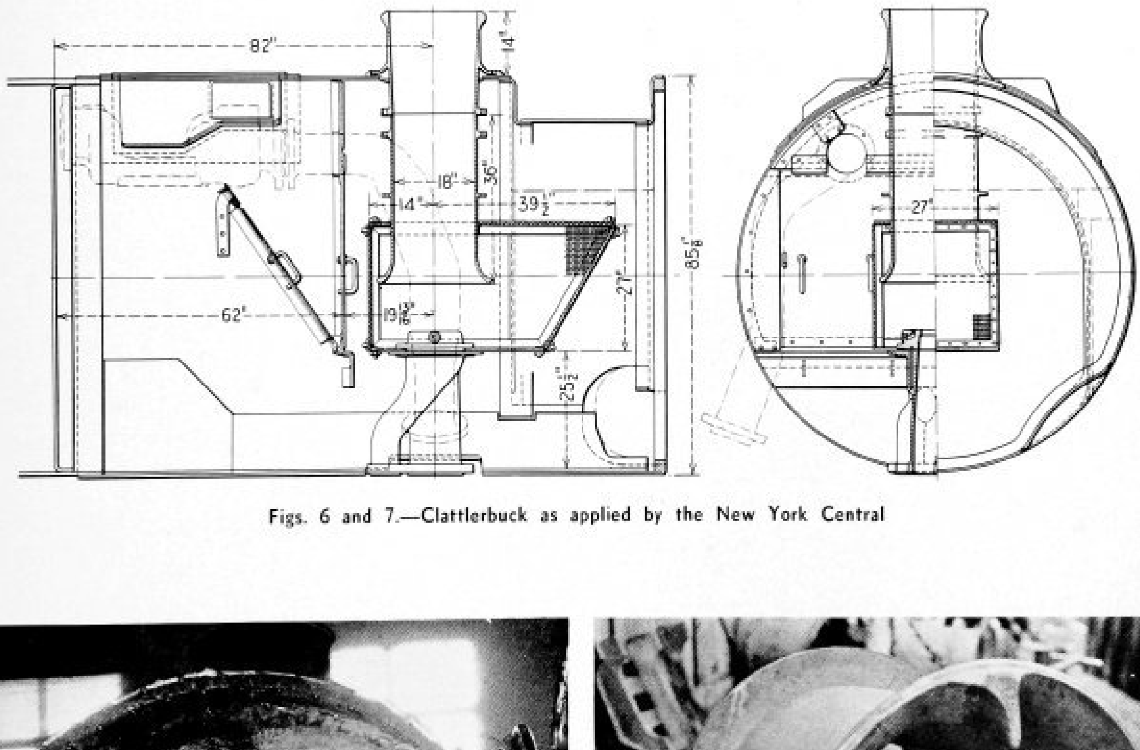


Fig. 3.—Exhaust nozzle tips with wedge shaped deflectors

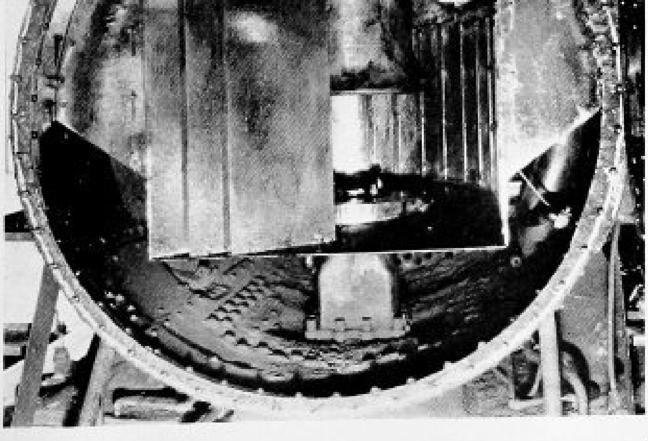
* This report was prepared by a committee composed of the following members: J. M. Stoner, supervisor of boilers, New York Central System (Lines West), chairman; E. M. Cooper, district boiler inspector, Baltimore & Ohio Railroad; H. E. May, general boiler and locomotive inspector, Illinois Central Railroad; G. E. Young, boiler foreman, Reading Railroad.



Figs. 4 and 5.—New York Central application of circular netting



Figs. 6 and 7.—Clattlerbuck as applied by the New York Central



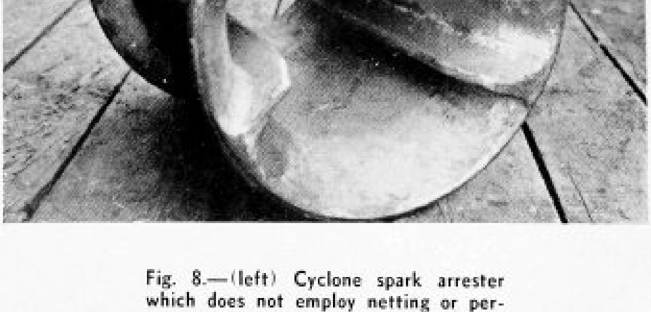


Fig. 8.—(left) Cyclone spark arrester which does not employ netting or perforated plate. (above) Fig. 9. Vanes are cast in the lift pipe to stop the whirling motion of the exhaust gases

Company. This device is used on a number of railroads and consists of multiple baffles set up in cylindrical form around the exhaust nozzle and lift pipe. If maintained in proper condition this is a positive baffle for any spark that might be emitted at the stack. This device performs the function of a spark arrester without employing netting or perforated plate. It is constructed of solid plate as shown in Fig. 8. It is arranged to create a cyclonic movement of gas and live sparks that results in sparks being reduced and extinguished and this action in connection with the vanes that are applied in the lift pipe to stop the whirl, as shown in Fig. 9, completes the installation and makes a compact and durable application eliminating fire hazards, as well as the possibility of the netting becoming stopped resulting in poor steaming and other troubles.

From the days of the diamond stack with the inverted cone and netting in the top that always had a hole and the old-timers that had the netting spark arrester in the smoke arch that trapped all sparks and let none get away, but which needed first aid frequently from the spark hopper and cinder blower, down to the present day where we have modern power, the front end equipment, as stated in the opening paragraphs of this paper, has progressed step by step with other improvements and at the present time is equal to present day demands.

Discussion

B. C. King (Northern Pacific): Due to the great number of costly fires set by sparks from locomotive smoke stacks brought about the use of a cheaply mined sub-bituminous coal that we were burning at a considerable saving, we were forced to consider one of two alternatives in order to protect the forested and agricultural areas—principally wheat—along our right of way.

The first alternative was the use of much higher grade and priced coal, and possibly oil on a part of the line, in order to reduce fire hazards.

The second was to secure a spark-arresting appliance by abandoning the conventional netting arrester, substituting some device that would effectually kill all live sparks before leaving the smoke stack and at the same time maintain the same freedom of draft obtained with the various netting front end arrangements.

The latter course was decided upon and immediately we began experimenting with what is known as the Cyclone spark arrester, which was the idea of one of our fuel supervisors. Since it has been perfected fires along our right of way have been reduced to a minimum and the performance of the locomotives has been improved far beyond our expectations.

Nozzle tip openings have been increased from 15 percent to 25 percent over those in use with previous netting and standard Master Mechanic types of front end arrangements. This of course meant a considerable reduction in cylinder back pressure and permitted an increased tonnage rating for all our freight power; in fact, we claim the distinction of creating an appliance that permits increased speed, increased tonnage without increasing fuel consumption cost.

In 1933 a test of merit of this device was made by the United States Forestry Commission through our most hazardous fire zone and it proved so successful that it was highly recommended and all locomotives in that territory are now equipped with this device.

In addition to those cited above, we have noted the following list of savings:

1. Faster steaming when firing up in roundhouse, due to less friction through Cyclone drum, no nettings to sweat.
2. No delays, such as stopped-up nettings due to steam leaks.
3. Engines do not fail so quickly when steam or air leaks occur in smokebox or firebox.
4. Not so much labor is required in fire prevention work along right of way.
5. The cost of round house inspection of front end is much less.
6. Defective conditions are more easily detected; repairs to same are more accessible.
7. We have had the lowest fire losses in our history.
8. Cinder cleaning of front ends is entirely eliminated; there are no cinders to wheel out of the round houses.

A. A. Swanson (Southern Pacific): Out West we have a condition similar to what you have here to a certain extent. We equip our engines with a netting similar to the coal-burning netting, as you do here. It is, in fact, the same type of netting that the coal-burning engines have.

In the San Joaquin Valley, from whence I come, we have a very dry grain district and we have tried to overcome fires by using this netting.

Frank Yochem (Missouri Pacific): On the Colorado Division we recently applied forty Cyclone front end spark arresters. We are out there in the prairie country where there is a lot of wheat and the application was made to eliminate fire hazard.

Originally we had the two and a half by two and a half mesh netting. We went from that to this draft tack netting which was 3/16 inch by ¼ inch slot wire, and we reduced our fire claims, if I am right, around forty or fifty thousand dollars the first year we had it in. We now have equipped these engines out there with the Cyclone front end, and we have had wonderful results. Due to the action of the cinders, of course the side walls do not last so very long, but while the maintenance is considerable, we figure that we are saving a great deal of money by their application.

Whether it is a Master Mechanic's front end or any other type, we must be careful not to have any holes larger than the mesh of the netting. We gage all our sheet metal work and regardless of what style front end it may be, we are not allowed to have an opening over 3/16 inch.

At the present time, we have one oil-burning engine equipped with the Cyclone front end for test. This engine came out of the shop about two months ago and so far we can not estimate what the results will be, since it has not been applied long enough to determine whether the fuel saving is worth while or not. On our other oil-burning engines, we do not have spark-arresting appliances.

T. H. Moore (Western Maryland): We have two hundred and thirty Cyclone fronts on our road. We are running anywhere from 80,000 to 100,000 miles. Up to the present time we have not spent anything on the Cyclone front,—not a thing. Before, we were repairing nettings every thirty days at the boiler wash periods.

Master Boiler Makers Hold Business Meeting

(Continued from page 270)

Election of Officers

As the final order of business the election of officers was held on the basis provided by the revisions made to the association by-laws. The results of the election follow:

President: M. V. Milton, chief boiler inspector, Canadian National Railways.

Secretary-Treasurer: Albert F. Stiglmeier, general foreman boiler maker, New York Central System, West Albany Shop. Address, 29 Parkwood Street, Albany, N. Y.

Executive Board—Three Years: William N. Moore, general boiler foreman, Pére Marquette Railroad; Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis Railroad; E. C. Umlauf, supervisor of boilers, Erie Railroad.

Executive Board—Two Years: M. V. Milton, chief boiler inspector, Canadian National Railways; Charles J. Klein, locomotive inspector, Interstate Commerce Commission: Sigurd Christopherson, supervisor of boiler inspection and maintenance, New York, New Haven & Hartford Railroad.

Executive Board—One year: George L. Young, boiler foreman, Reading Company; C. W. Buffington, general master boiler maker, Chesapeake & Ohio Railroad; A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific Railroad.

The vice-president who will be elected at an early meeting of the executive board will also serve as chairman of that board.

Application to boilers and tenders of

Fusion Welding*

In presenting this report your committee respectfully requests your careful consideration and study of the use of fusion welding for the construction and application of boiler flue sheets, throat sheets, mud rings, backheads, barrel courses, in fact, for the entire boiler and tender structure.

The use of welding for the construction of fireboxes, the application of firebox patches, the safe-ending of flues, and the installation of flues in the flue sheets, as well as for the application of patches to the boiler shell within the stayed zone has become generally the recognized practice.

In order that progress may continue, and that modern developments may be utilized, the field in which so useful a process as that of fusion welding is employed for railroad operations must be enlarged; otherwise the railroads will lag far behind other branches of industry.

The uncertainty that once surrounded the art of welding has been removed. Welders were trained to produce dependable welds with satisfactory regulations even before the event of the special electrodes and electric welding machines which are now available for this work without involving to any great extent the human element. With the modern machinery and equipment now available for producing reliable welds and with X-ray machines for investigating the condition of the completed work, there is now nothing to fear in so far as the dependability of fusion welding is concerned.

From the standpoint of boiler and tender repairs there is no phase of the work more important than fusion welding. Both the oxy-acetylene and electric processes are in use, some doing the majority of their work by one and some by the other. There have been many problems to work out but the art has now progressed to the point where practicability and serviceability are on a high plane and costs have been materially reduced.

Both the oxy-acetylene and electric processes have a definite place in the art, one being superior for some jobs and vice versa. It is, therefore, necessary to experiment and determine which will give the best results. We can see no reason why fusion welding should not be used for every detail of boiler construction, one after the other, testing and perfecting the work until the entire boiler is constructed by welding. However, we must not lose sight of the thought that is uppermost in the minds of everyone, that greater speed and greater pressure are the big words in the railroad and industrial field today. Behind the scenes of this new drama of greater speed and greater pressure are the men who watch, test, analyze, design, build—men who are making it their first duty to safeguard the railroads' and industry's most priceless asset, their remarkable record of safety. Already we are seeing all-welded locomotive fireboxes, tenders and stationary boilers, reading of more advanced fusion welding practices; with characteristic thoroughness, the railroads and industry today are welding with caution and safety.

It is only logical that fusion welding should have brought into the field much new and valuable knowledge of standards and practice. For more than a quarter of a century fusion welding has been used in fabricating products basically similar in nature to locomotive riveted, cast and forged parts. During these years the master boiler makers of this association with the support and co-operation of others in the railroad and industrial fields have been responsible for many basic advances in processing, resulting in favorable characteristics in the micro-structure of the finished parts. In fact, much of this basic research and development is today reflected in the requirements as set forth by this association and official standards and codes.

When fusion welding was first studied by our members it was apparent that better results could be obtained, for the first attempts were critically examined and compared exhaustively with similar riveted, cast and forged parts. The highly favorable findings were checked by competent specialists from the mechanical departments of our leading railroads. Without fear of con-

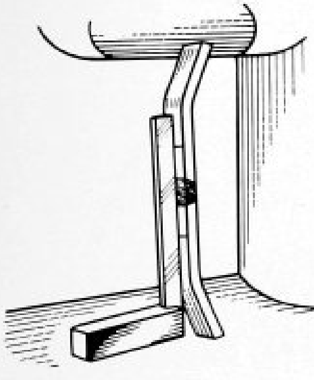


Fig. 1.—Start of the free bend test for ductility

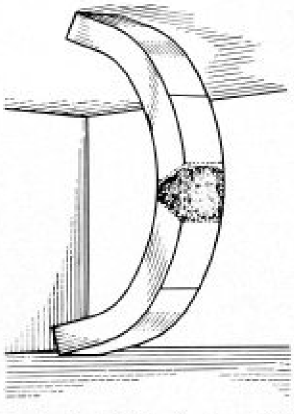


Fig. 2.—End of the free bend test

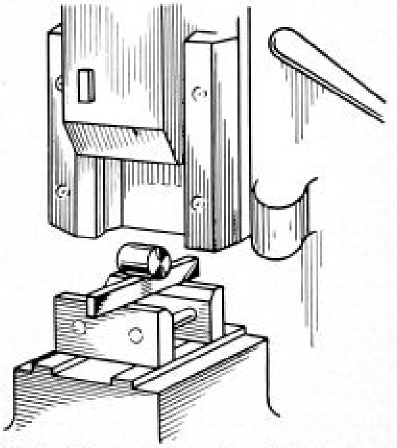


Fig. 3.—Coupon in place for nick break test

* An abstract of a report prepared by a committee composed of the following members: Albert F. Stiglmeier, boiler foreman, West Albany Locomotive Shop, New York Central System, chairman; John A. Doarnberger, master boiler maker, Norfolk & Western Railroad; S. Christopherson, supervisor of boiler inspection and maintenance, New York, New Haven & Hartford Railroad; H. H. Service, general boiler inspector, Atchison, Topeka & Santa Fe Railroad; G. E. Stevens, general boiler inspector, Boston & Maine Railroad.

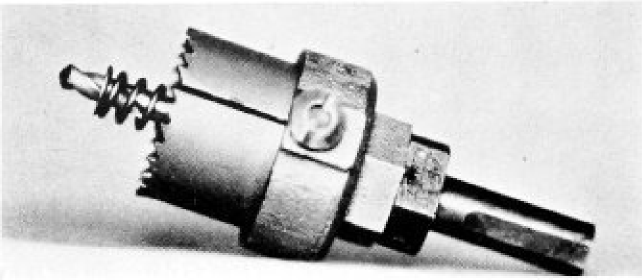


Fig. 4.—Trepanning tool for weld sampling

tradiction, it can be said that the fusion welding processes developed marked the most important and basic advance in locomotive boiler and tender construction for many years.

There can be no better proof of the value of fusion welding than the complete welding of pressure vessels. There should be no hesitation in its recommendation and adoption by our association for locomotive boilers, especially since there is under construction by one of our leading railroads an all-welded locomotive boiler. Not having complete information concerning its details at this time, we refrain from publishing the description. With all these accomplishments in view, your committee has prepared and is presenting to you, studies of several details of boiler construction in which they feel flanging, riveting and other expensive operations may safely be replaced by welding. Also we present various articles and papers from research engineers which we know will be of much value and benefit to you and your railroads. Your earnest consideration and discussion of them are solicited. The following is by W. D. Halsey, assistant chief engineer, boiler division, Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.:

Fusion Welding

Fusion welded vessels, when properly made, possess many advantages over riveted vessels. The most striking of these is their relative freedom from leakage. They can be constructed with less weight of metal than is required in riveted vessels to fulfill the same purpose, and can be fashioned in rather complicated shapes with greater ease.

These advantages have been recognized for a long time, but fusion welding was slow in gaining the confidence of users of pressure vessels, governmental regulatory boards, and boiler insurers. Safety could not be sacrificed in the interest of a slight saving in construction cost, and such attempts as were made to apply fusion welding to pressure vessels were hampered and discouraged by their frequent and disastrous explosions. Riveting maintained its popularity for many years because of its general dependability. It was recognized that a riveted vessel could be ruined by improper methods of fabrication, but the pitfalls were so well known and proper practices for riveted construction had been so standardized, that engineers had confidence in its trustworthiness.

The use of the electric arc and oxy-acetylene process of fusion welding received great impetus during the World War, and following the war there was a strong urge on the part of many to give greater recognition to fusion-welded vessels and those in charge kept in close touch with the experience that was being obtained, but for several years the records of accidents which it compiled convinced it that the time had not then arrived when fusion welding could be recognized as a sufficiently reliable method of construction.

The prime need was to find methods that would give uniformly dependable results. Several of the leading manufacturers courageously accepted the challenge. Great strides were made by some, and engineers were

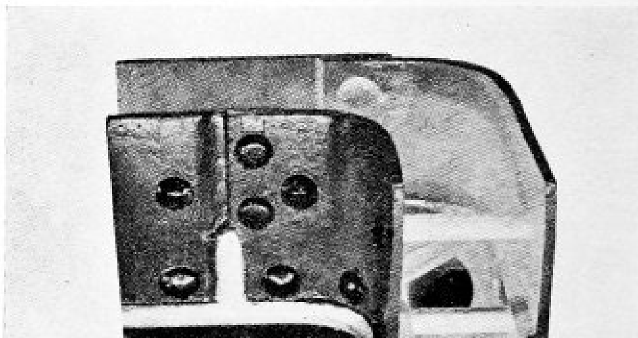


Fig. 6.—Model of firebox ring showing corner construction of mud ring and firebox sheets

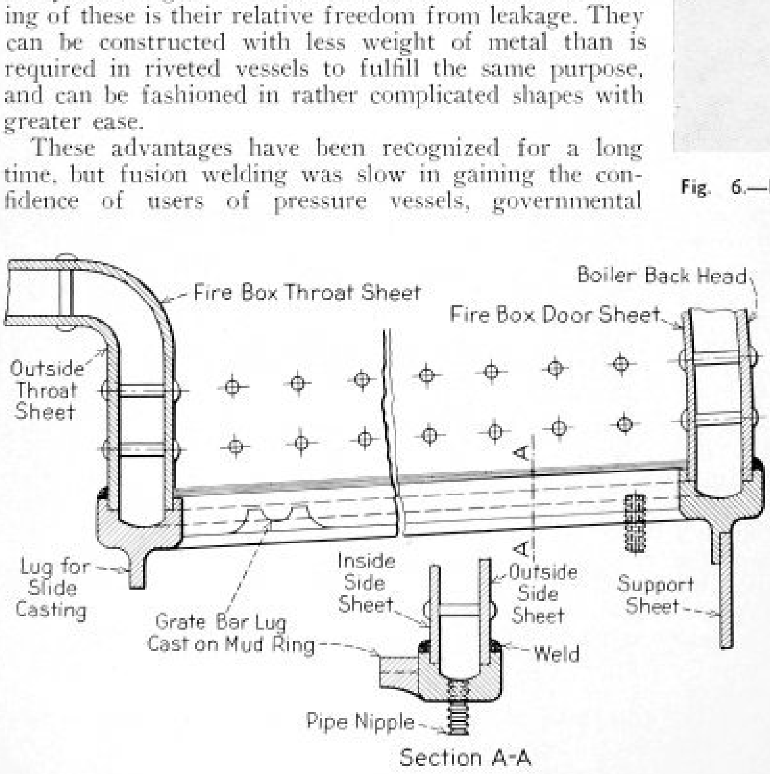


Fig. 5.—Mud ring showing sheet recess

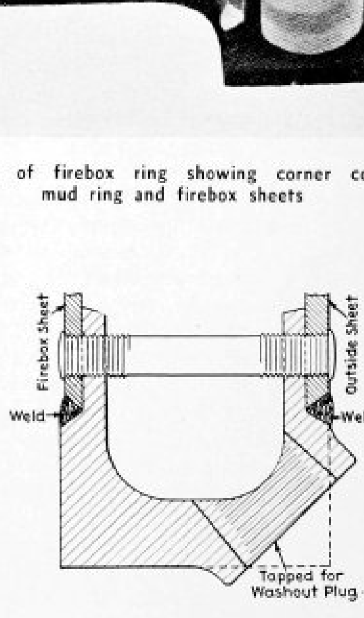


Fig. 7.—Sectional view of mud ring showing method of attaching to firebox sheets

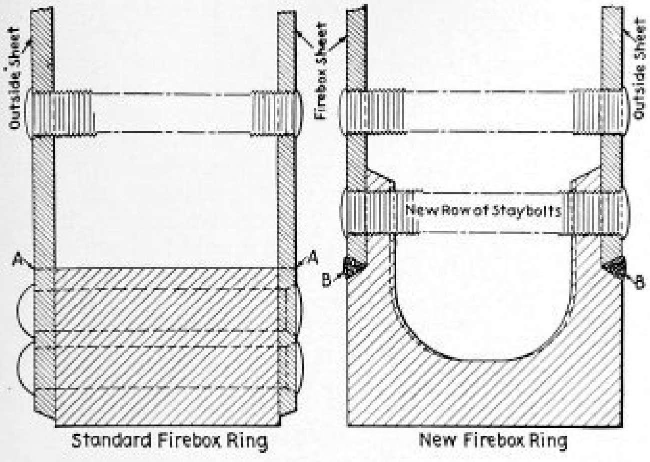


Fig. 8.—Standard firebox ring construction (left)—replaced by new ring (right)

not slow then in acknowledging that their development had brought fusion welding to a point where it merited more recognition. The manufacturers who had made the progress were given an opportunity to prove that they had developed processes yielding sound fusion welds with acceptable physical characteristics, and their vessels were declared acceptable for insurance.

However, having thus accepted the product of a few makers as insurable, the company saw that in fairness to all manufacturers, as well as for the protection of prospective purchasers of vessels, some well defined standard of welding would have to be codified, and tests would have to be devised whereby it could be determined whether or not a manufacturer was meeting the standard. Those in charge, therefore, undertook the responsibility for an investigation which afforded it the opportunity of pioneering in a new field just as it had pioneered years before in establishing the standard for riveting.

In the opinion of our engineers there are three physical properties that every weld must possess if it is to be considered safe. These properties are sufficient tensile strength, ductility, and soundness, and the means of determining these properties as developed or adopted by the engineers are recognized as fully adequate for the purpose.

Fusion welds have sometimes been judged by their exterior appearance. It is possible to make some rating of a weld in this manner, but it is utterly impossible thus to determine its full value. In fact, engineers have seen some welds of very fine external appearance which on examination proved to be entirely untrustworthy, consequently, the engineers felt that if good work was to be assured, the problem would have to be attacked at its source—in the shop where the welding is done. Early in the preliminary studies, it was decided that successful fusion welding depended on two major items: First, the development of a process which would give the required results; and second, the training of the individual welders to follow this process. Obviously, the most experienced welder cannot obtain satisfactory results if he does not have the proper materials to work with, and conversely, an inexperienced and untrained operator will not obtain satisfactory results even with the best of material and equipment.

Our company's investigation resulted in establishing the following procedure: When a manufacturer desires to obtain approval for his fusion welding, he is required first to furnish a written statement outlining his process in detail. He must then fabricate a number of welds in accordance with the specifications which he has submitted, and these sample welds are subjected to the special method of testing adopted by our company. If the welds pass the test successfully, the manufacturer is placed upon the approved list. This means that he has demonstrated to us that he has a process whereby fusion welds can be made which will meet our requirements. However, before building fusion-welded vessels which will be acceptable to us, he is required to show that all welders who work on the vessels have, by special qualification tests, proven their ability to obtain the desired results. Furthermore he must arrange for inspection by a representative of our company during the time vessels are being fabricated. By this means we have satisfied ourself that our requirements for construction have been met, and are thus in a position to certify to the purchaser that the boiler will be satisfactory.

In measuring ductility a difficult problem is presented. If the failure in the tensile test specimen would always take place within the weld the ductility could be measured in the conventional manner between two points located on the weld metal. But as the failure does not always occur so that this measurement can be properly made, this means of testing ductility is not practicable. It has been suggested that ductility be obtained by drilling holes in the weld so as to force failure to take place within the weld metal, and then measurinig the elongation of these holes. This, however, is not a satisfactory method, as the stretching of the holes varies to a very considerable degree, being influenced by the proportion which the size of the holes bears to the metal remaining between them.

The present accepted method of testing for ductility of the weld metal consists of measuring the stretch on one surface of the welded joint, and is known as the free bend test. In Fig. 1 is shown a specimen prepared for test. Two center punch marks or scribed lines, are made

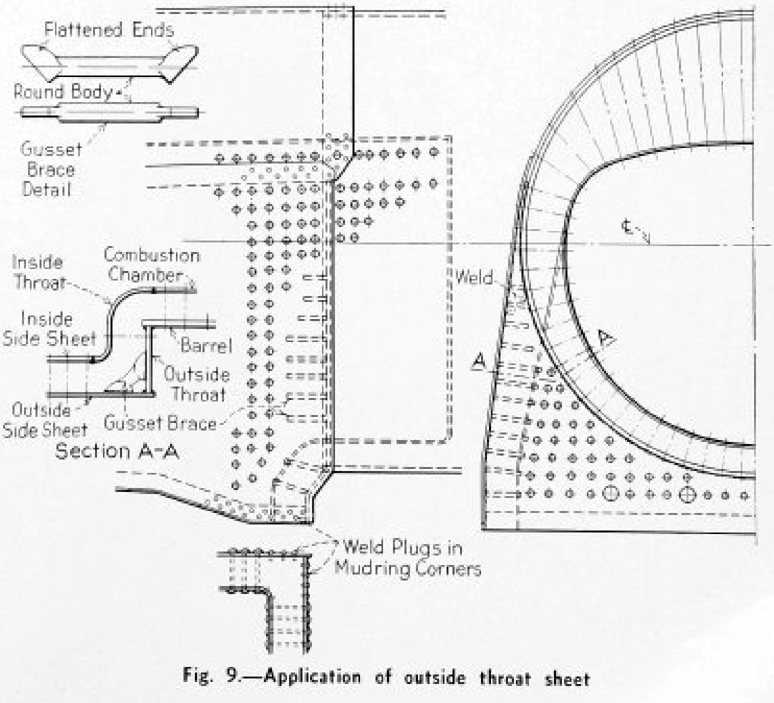


Fig. 9.—Application of outside throat sheet

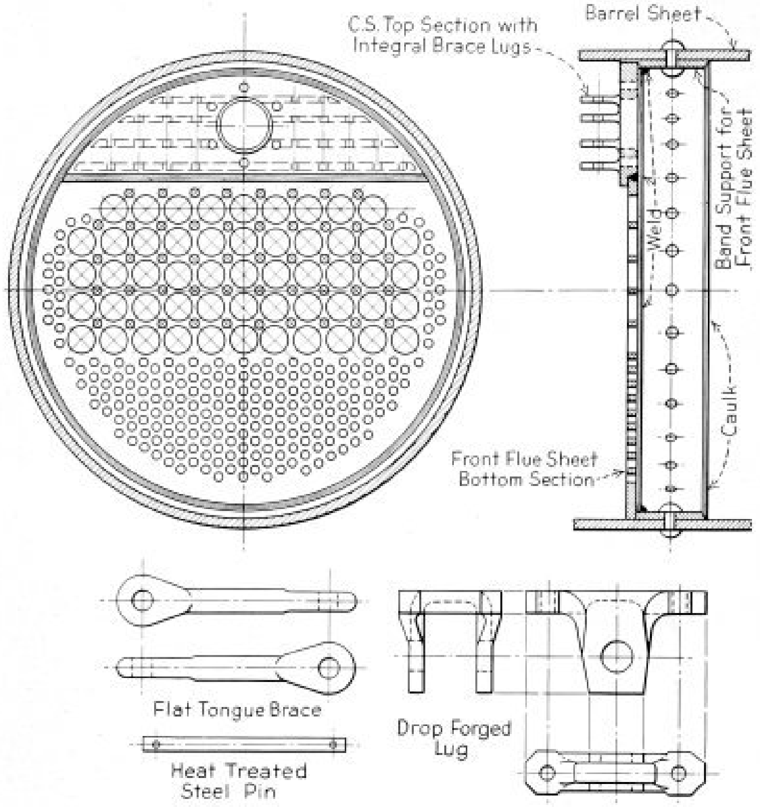


Fig. 10.—Flue sheet and bracing application

on the surface of the weld metal slightly inside of the juncture of the weld metal with the base or parent metal. The distance between the two lines is measured and recorded and the specimen is then bent as shown in Fig. 2, the maximum bending being forced to take place at the weld. When failure takes place in the surface of the specimen in the weld, the test is stopped, and by means of a flexible steel scale the distance between the two reference marks is again measured. The ductility of the weld is recorded as the percentage of increase of the

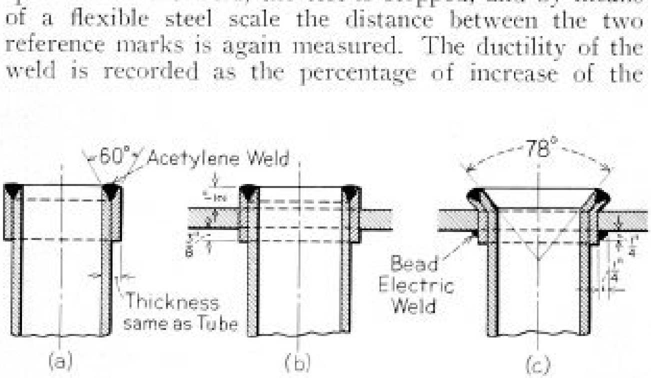


Fig. 11.—Welding of arch tubes to firebox sheet and nipples

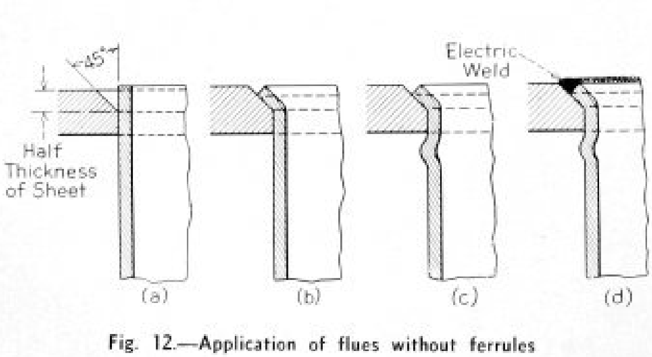


Fig. 12.—Application of flues without ferrules

distance between the two reference marks.

The nick break test is for determining the soundness of a weld. It consists of making notches or saw cuts in a specimen and of breaking the specimen by one sudden quick blow, preferably under a hammer as shown in Fig. 3, or some other heavy falling weight. This test snaps the weld apart and enables one to see the character of the weld metal, it discloses how thoroughly the weld had penetrated from one side of the plate to the other, whether there are any oxide or slag inclusions, what degree of porosity may exist and gives some idea of the crystalline structure of the weld metal.

The American Society of Mechanical Engineers Boiler Code established three classes of fusion—welded unfired pressure vessels in addition to fusion—welded drums for power boilers. The most severe requirements of the A.S.M.E. Code are those for power boiler drums, because power boiler drums are subjected to the most severe service and are potentially the most dangerous class of pressure containers. A Class I unfired pressure vessel is not restricted as to pressure, temperature or kind of service and the requirements which must be met are practically the same as those for a fusion-welded power boiler drum.

Therefore, it is required that the principal seams of all Class I fusion-welded vessels or power boiler drums be examined by the use of the X-ray at the plant of the manufacturer if such vessel or drums are to be used and receive approval.

Trepanning Weld Samples

While Mr. Halsey's paper gives methods of inspection of welds, such as the X-ray, there are other methods that can be followed to determine the soundness of the welded joint, such as trepanning. At several points, plugs are cut out from the welded seam, and then etched to detect lack of fusion or slag inclusions. The idea of trepanning the plug is, of course, very old but the method has only recently been extensively used in the examination of welded seams where the X-ray method was not available. The tool used for this purpose is shown in Fig. 4. While similar tools have been on the market for some time, it is only recently that the cylindrical saw has been available in high-speed steel. A tool is needed that will withstand severe service and is quite necessary for this kind of work.

An innovation in boiler construction is presented in the accompanying illustrations of cast-steel mud rings in which the backhead, door, throat and inside and outside firebox sheets are secured by electric welding instead of the conventional method of riveting. Although data as to the durability from an actual boiler installation is not available, a test with hydrostatic pressure of a section of this construction has demonstrated conclusively that the strength of the welded cast-steel mud ring developed as high resistance to failure as the stay bolted area of the sheets.

In Fig. 5 we have a mud ring with the sheets set into a recess inside of the ring, whereas in Fig. 6, 7 and 8 we have the sheet set into recess on the outside of mud ring with one row of staybolts through the sheet and mud ring.

The first cost and weight of mud rings of the electrically welded type are approximately one-half of that of the conventional riveted type. Economy in application of the cast-steel welded mud ring results from the elimination of the following operations which must be performed with the riveted type:

Planing and milling in finishing.

Laying off and drilling rivets in the mud ring and sheets which are attached to it.

Planing and beveling sheets for calking also the calking operation.

Reaming rivet holes and driving mud ring rivets.

Drilling and attaching sheets at mud ring corners.

Maintenance costs will be reduced because of:

It being unnecessary to cut out and renew mud ring rivets in making side sheet renewals.

The prevention of side sheet pitting at the top of the mud ring, thus minimizing side sheet renewal.

In mud ring to Fig. 5, it is possible to cast integrally the grate bearer and ash pan support lugs, thereby eliminating separate grate bearer and ash pan support castings.

In both type of mud rings, inlet openings may be made through the mud rings for washout plugs, blow-off connections or any other desired attachments.

The elimination of leakage, particularly around the corners.

In addition to the potential savings in application and maintenance costs, the electrically welded mud ring offers a flexibility of design which is not possible with the riveted type.

In view of the many attractive features offered by this design of mud ring and of the fact that it is of equal, if not greater strength than the riveted type, this development bids fair to supersede the riveted type of mud ring in future boilers.

Electrically Welded Outside Throat Sheet

Application of the outside throat sheet, Fig. 9, by the conventional method of flanging, fitting, drilling, reaming, chipping, riveting and calking, causes this to become the most expensive member in boiler construction to manufacture and apply.

A saving of more than fifty percent in material and labor costs is possible by substituting an electrically welded throat sheet for the flanged type and a study of this feature reveals that an installation of ample strength and extreme simplicity can be made.

To install the electrically welded throat sheet, the front corners of the mud ring are made square and the side sheets project forward beyond the squared edges at these points a distance equal to the thickness of the throat sheet plate plus the length necessary for a welded joint. The boiler shell course is not cut away at the bottom as is done with the flanged type of throat sheet but is allowed to remain as formed from the rectangular plate. The side sheets above the mud ring are extended forward to overlap the rear face of the boiler barrel course by an amount equal to the thickness of the throat sheet plate and the length for the welded joint.

The plate forming the throat steel is then cut and bent to fill the space between the side sheets and under the boiler barrel, after which it is welded to these members. Before application of the firebox, gusset braces are welded across the corners between side and throat sheets, to provide necessary stiffness. Attachment of the throat sheet to the mud ring can be made either by riveting or welding. In manufacture, plates for the electrically welded throat sheets will be cut to shape, stacked and drilled, bent and welded in, displacing the costly forming, fitting, drilling and application operations necessary with the flanged type.

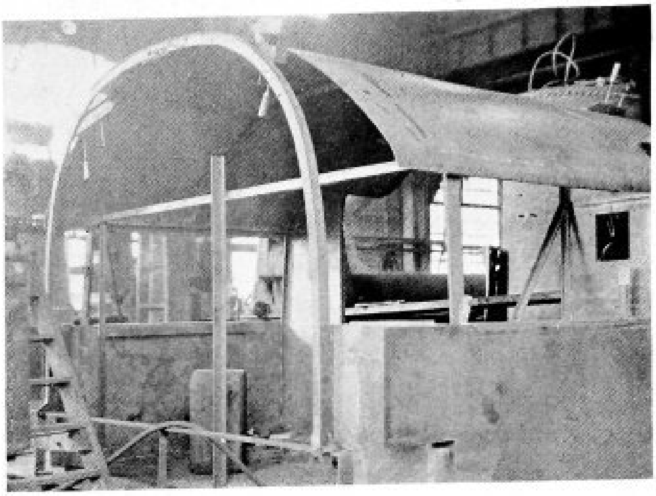


Fig. 13.—Cab in its first stage

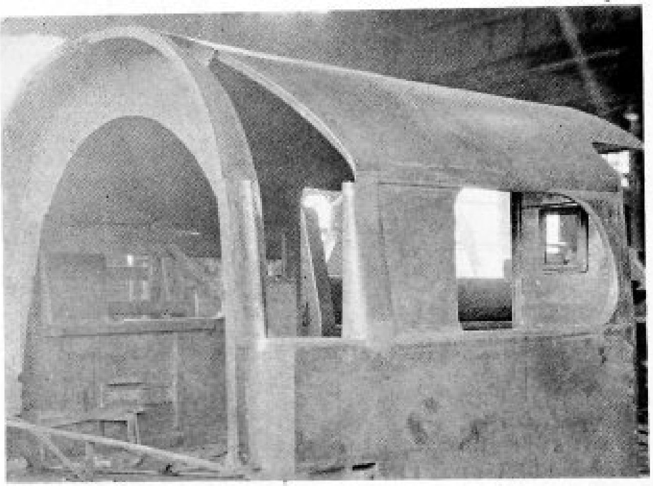


Fig. 14.—Cab partially completed

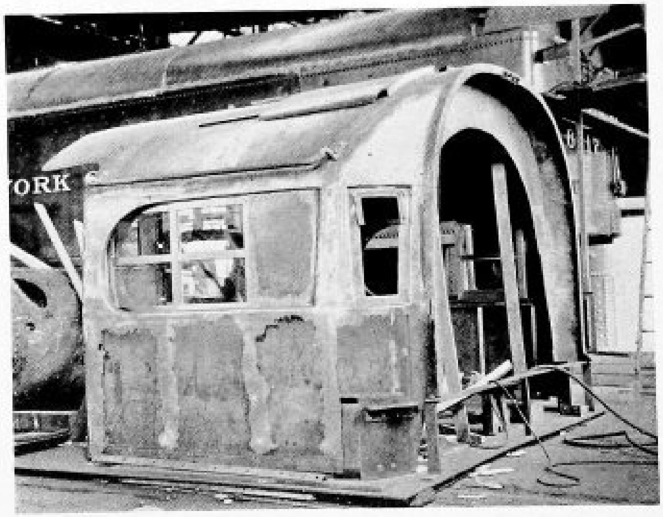


Fig. 15.—Cab completed and ready to be sand blasted

Leaks at rivets and calked edges as well as cracks which develop in the hip knuckles will be eliminated through the absence of flanging and the welded construction.

The simplicity and economy of manufacture and application of the electrically welded throat sheet, together with the fact that careful analysis has failed to disclose any weakness in the construction, warrants serious consideration by boiler designers, builders and users. Perfection of this type of construction will be one of the principal problems for future electric welding advocates.

Flue Sheet Application and Bracing

It has been a standard practice for a number of years on a prominent railroad to apply to their boiler what is termed a banded welded front flue sheet, which consists of riveting a ring to the boiler shell and welding an unflanged flue sheet to it. This method of construction has proved extremely satisfactory and experience has demonstrated that it possesses many advantages over flanged sheets, both as to first cost and maintenance. Elimination of the flanged knuckle by this means has also eliminated the trouble with cracks which occur in the knuckle of flanged sheets.

This same railroad has been conducting some experiments in simplifying the attachment of the braces to flue sheets through the application of cast steel brace lugs welded together into a unit and riveted to the sheet. The welding process was necessary because of drilling the holes in the lugs for the brace attachments which were cast vertically, thus necessitating that the castings be made in sections.

It has been found that a unit casting, with the brace lugs cast on transversely, can be used as the top portion of the flue sheet, and this casting welded to the bottom section just above the flues. The holes for brace attachments can be drilled vertically through the lugs and this unit casting eliminates the separate lug castings as is shown in Fig. 10.

The braces used with this construction are quite simple, consisting of rods with flat tongues forged on each end. In manufacturing them it is only necessary to upset the ends and drop-forge the tongues. Drop-forged U-shaped lugs are also used for attaching the brace ends to the boiler sheet.

There is offered here a design having a strength equal to that of the conventional type of construction. The simplicity and ruggedness, as well as the possible savings in manufacture and application, justify the use of this type of front flue sheet in replacement of existing types.

Application of Arch Tube

Arch tubes on high-pressure and combustion chamber fireboxes have been a source of much trouble to master boiler makers, and many methods of application have been put in practice. The one shown in Fig. 11 (a), (b) and (c) is worthy of recommendation, its application is as follows:

Fig. 11 (a) Arch tube after being cut to its proper length to suit the firebox, is welded to the nipple at its end, both nipple and tube having been beveled to 60 degrees, electric or acetylene welding being used, preferably acetylene.

(b) Tube and nipple are inserted into the sheets and expanded with a seven-roll flaring arch tube expander.

(c) Tube is sealed to the firebox sheet with acetylene or electric welding, preferably electric.

The above application without doubt has strength, the simplicity of application and its ruggedness, as well as the possible savings in maintenance justify the use of this type of arch tube application.

In years past and at the present time copper ferrules have been and are being used in the back tube sheets as the term might apply, because in using it, a tight joint is possible. But with the present-day use of shielded arc, we are wondering if the copper ferrules should not be eliminated when shielded arc is used, as difficulty has been encountered because the high heats in these rods effect any copper ferrules that might be present, by setting up expansion and contraction strains which are the cause of the cracking of the weld metal.

Your committee has been given information by one of the leading railroads, which has put in practice a method that has overcome this difficulty and satisfactory results in service have been made. That is the method of applying flues without the use of copper ferrules in the back tube sheet and is as follows:

Holes in the firebox tube sheet are drilled to the size of the swedge on flue, hole countersunk to 45 degrees on the fire side of sheet, half the depth of the sheet thickness.

Fig. 12 (a) Shows the flue inserted into sheet, 1/32 inch over flush on fire side.

(b) Flue rolled into sheet with roller expander, and flared with flaring tool or flaring roller expander.

(c) Flue expanded with sectional expander.

(d) Flue sealed to tube sheet with autogenous welding, preferably electric arc.

Autogenous Welding as Used on Electric and Streamline Locomotives

At the present time the master boiler maker is being called upon more than ever to construct tanks and other parts that will fit in line with streamline and electric locomotives, where space and weight are at a premium, said parts being light in weight and of smooth surface, and the master boiler maker must familiarize himself to meet these demands.

An all-welded steel locomotive cab was recently built for one of our leading railroads, to be installed on an outstanding streamline locomotive, where smoothness was the watchword and the entire cab being jointed together by fusion welding, with the exception on bolts that hold parts that are removed from time to time.

The last part of the report was devoted to an abstract from an article published in the May, 1936, issue of the Boiler Maker and Plate Fabricator, dealing with the procedure to be followed in joining nickel-clad steel plates by welding. Permission to reprint this material was given through the courtesy of the International Nickel Company and the Lukens Steel Company.

Discussion

J. A. Doarnberger (Norfolk & Western): We will take up the cast steel mud ring. You will notice that the inner and outer sheets rest on the inside of this mud ring and they are welded along the edges. We also have it so that we can tap into any part of the mud ring, which you cannot do with a riveted mud ring. We can make any kind of blow-off connections we want. Lugs can be cast on to trunnions and do away with side bearers.

In the mud ring that is going to go on the electrically welded boiler, you will note that the sheets set on the outside of the mud ring and are welded along the edge with a vee weld, having a staybolt engage the outer and inner wrapper sheets and through the mud ring. Very good.

In applying a firebox or side sheet or patches to the mud ring, it is only necessary to burn out the sheet, release the staybolts and chip off the welding and lift it out. Replace it in the same manner, eliminating all the maneuvering with rivets.

We made a test of this mud ring by building a box 6 feet long, 4 feet high, the outside wrapper sheet ½ inch and firebox sheet ⅜ inch. We had a staybolt pitch of 0.375. We started to test it, had strain gages and everything on the test. We took the record as the pressure went up.

At a little over 1000 pounds, the firebox sheets commenced to corrugate. We held that pressure and took our measurements. We got up to 1100 pounds. We increased our pressure in steps of a hundred. When we got up to 1300 pounds, the first thing that gave way was the staybolts in the firebox sheets and they commenced to leak very profusely. Next the outside sheet.

We held that until we couldn't hold the pressure any more at 1300 pounds to the square inch on that mud ring. That is a fact!

Now we come down to this throat sheet. Has it ever occurred to you that the throat sheet is the most expensive plate that goes into a boiler? By the time you make the dies, press the sheet, form it, fit it, drill it, plane it, bevel it, rivet it and put it in, we lose 59 percent of that sheet as it comes from the mill.

(Mr. Doarnberger by means of sketches indicated how sheets could be laid out and cut to eliminate much of this waste.)

Now we will take the front flue sheet. Don't fool yourselves but that this front flue sheet is going to cost about 10 to 12 percent more than the flanged and riveted sheet. That isn't what we are after. When we put this band in and weld it and draw the flue sheet up against the mud ring and weld it on this side, what we were able to get away with and have gotten away with since 1924 or 1926 is to eliminate water cracks around the knuckle.

In this committee's report here it says: "In conclusion, your committee recommends that the Master Boiler Makers' Association go on record in favor of the all-welded locomotive boiler." This is certainly tardy news to me. If you refer back to 1914 you will see in the Proceedings of our convention that I made a prediction that we would all live to see an all-electrically welded locomotive boiler, and our dreams have come true!

H. H. Service (Santa Fe): I think each man has safety in mind when these designs on autogenous welding are made. Tests should be followed in accordance with the recommendations as adopted by one's own railroad, and improvements made in that department from time to time. In that way you have the full knowledge of what is going on in the welding department.

J. A. Graulty (American Locomotive Company): The first all-welded locomotive boiler is now under way.

What we propose to do is to have the Class I welding done at our Dunkirk plant. The reason for that is that they have a radiograph machine there and they propose to X-ray all the welds. After the welding of the boiler is completed they are going to take it to Chattanooga, Tennessee, and stress relieve it. Then it comes back to Schenectady where we will apply the firebox and complete it. The braces are riveted, the T-irons of course are riveted. Those are about the only things not welded on the whole boiler.

We will be glad to have any of you come down at any time and inspect this work.

Frank Longo (Southern Pacific): We have found that joining sheets in the locomotive firebox by the electric arc process, using a heavy coated rod, has effected considerable economy both in firebox construction and maintenance cost, as welds equal to or better than the plate itself in tensile strength, ductility and ability to withstand repeated stresses are obtained.

The type of weld used in our new fireboxes of course is typical of all welds in fireboxes, a single vee. The welding of superheater flues in the back flue sheets of our locomotives was first started in 1916 with the oxy-acetylene process. At that time our welders, myself and others, welded one superheater flue per hour. With our present method of electric welding flues, we weld in thirty-six flues per hour at a cost of six dollars.

Secretary Stiglmeier: I understand since we wrote this report there has been a change. When you expand flues you do not use a sectional expander; you use a roller expander.

Frank Longo: That's it. We have a machine that puts in this prosser mark when the flue is swaged, as you see in the *Proceedings*. The flue is set in and given a light rolling; set to the sheet; belled over and welded.

These superheater flues will run the life of a back flue sheet. On some occasions on our Mallet type engines, type E superheater units, we misinterpreted the law. Now a 3½-inch flue must come out once every four years. We misinterpreted that law and ran our locomotives longer than that until our attention was called to it. At the present time we have to take out the 3½-inch superheater flues, but our 4½-inch superheater flues run the life of the back flue sheet, which is eight years or more. In removing flues we burn them off and then chip them with a gun.

We do not use copper ferrules; the sheet is countersunk to a 45-degree angle. The flue is inserted 3/16 inch, coming flush with the sheet, belled over and just one bead is placed around the flue.

C. W. Obert (International Acetylene Association): In the stationary field, the entire industry turned from riveted boilers to welded boiler drums for watertube boilers to escape caustic embrittlement or embrittlement cracks.

After some thirty-five hundred or four thousand drums have been welded and put in boilers, some of which have been in operation as long as five years, there hasn't been the slightest indication of an embrittlement crack in a welded boiler drum. The only place where we could look for them in the watertube boiler drums,—conventional boilers of today,—is of course in the ligaments between tube holes in the shell portion. There are no laps or butt straps to contend with in that type of boiler drum. All of the insurance companies are watching very closely and up to date there hasn't been the slightest indication of an embrittlement crack in any of those welded boilers.

Registration at Master Boiler Makers' Business Meeting

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Barton, T. F., superintendent, motive power, Chesapeake & Ohio R. R., Richmond, Va.
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Bass, M., foreman boiler maker, Richmond, Fredericksburg & Potomac R. R., Richmond, Va.
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Deaton, M. A., district supervisor, Oxweld R. R. Service Company, 2843 Beverly Drive, Denver, Col.
Evans, P. W., engineer, National Aluminate Corporation, Hinsdale, Ill.
Fogerty, Kearn J., representative, Garlock Packing Company, 61 S. Lincoln Avenue, Aurora, Ill.
Green, A. G., locomotive inspector, Interstate Commerce Commission, Denver, Colo.
Gunderson, L. O., vice-president, Electric Chemical Engineering Company, 310 S. Michigan Avenue, Chicago, Ill.
Haring, R. A., general locomotive inspector, Wabash Ry., Decatur, Ill.
Haringan, John R., Southern Pacific R. R., 3611 Locke Avenue, Los Angeles, Cal.
Heberton, Craig, sales engineer, The Dampney Company of America, Bourse Building, Philadelphia, Pa.
Heiland, E. B., boiler inspector, Illinois Central R. R., Freeport, Ill.
Hislop, T. W., water engineer, New York Central System, 1346 6th Avenue, Watervliet, N. Y.
Hitch, C. B., assistant superintendent, motive power, Chesapeake & Ohio R. R., Huntington, W. Va.
Hunter, C. J., vice-president, The Dampney Company of America, Boston, Mass.
Ilgen, G. F., chief engineer, Airetool Manufacturing Company, Springfield, Ohio.
Johnson, S. C., assistant to vice-president, 1912 Straus Building, Chicago, Ill.
Knowles, C. R., superintendent, water service, Illinois Central R. R., Chicago, Ill.
Lumbard, Warner, business manager, Boiler Maker and Plate Fabricator, 30 Church Street, New York.
Macqueen, Volin, technical director, Dearborn Chemical Company, Buenos Aires, Argentine Republic.
Masters, W. C., sales engineer, Flannery Bolt Company, Bridgeville, Pa.
Matthes, W. E., sales department, Oxweld R. R. Service Company, 230 N. Michigan Avenue, Chicago, Ill.
Miller, R. H., water engineer, Ann Arbor R. R., member A. R. E. A. Commission, Owosso, Mich.
Moses, J. P., general manager R. R. sales, Joseph T. Ryerson & Son Company, Chicago, Ill.
Nieman, Chas. J., secretary-treasurer, Penn Iron & Steel Company, Creighton, Pa.
Obert, C. W., representing International Acetylene Association, 30 East 42nd Street, New York.
Olsen, Oscar F., general traffic manager, R. W. Castle Company, 1132 Blackhawk Avenue, Chicago, Ill.
Robersen, A. F., district boiler inspector, Great Northern Ry., St. Paul, Minn.
Rogers, C. M., service manager, Locomotive Firebox Company, 310 S. Michigan Avenue, Chicago, Ill.
Sampson, O. N., special representative, Oxweld R. R. Service Company, 230 N. Michigan Avenue, Chicago, Ill.
Seniff, R. W., chemical engineer, Alton R. R. Company, Bloomington, Ill.
Sherlock, R. J., president, Huron Manufacturing Company, 3240 E. Woodbridge Street, Detroit, Mich.
Shinkle, G. L., representative, Joseph T. Ryerson & Son Company, 1430 N. Central Avenue, Chicago, Ill.
Smith, I. A., assistant general superintendent, Oxweld R. R. Service Company, 230 N. Michigan Avenue, Chicago, Ill.
Walker, Adrian A., representative, Paulson Tool Company, 100 S. Jefferson Street, Chicago, Ill.
Walsh, W. R., Ewald Iron Company, vice-president, 80 E. Jackson Avenue, Chicago, Ill.
West, A. L., service engineer, Oxweld R. R. Service Company, 230 N. Michigan Avenue, Chicago, Ill.
Wiese, J. F., assistant to vice-president, Lukens Steel Company, Coatesville, Pa.
Wilson, W. M., sales manager, Flannery Bolt Company, Bridgeville, Pa.

Ladies

Bodine, Mrs. C. E., 2305 E. 12th Street, Sedalia, Mo.
Craig, Mrs. W. J., Baltimore, Md.
Grosshoff, A. W., Bowling Green, Cumberland, Md.
Laughridge, Mrs. W. H., Columbus, O.
Pool, Mrs. Ira J., Baltimore, Md.
Schmidlin, Mrs. Joseph, Cleveland, O.
Stoner, Mrs. J. M., Cleveland, O.
Wolf, Mrs. G. S., Little Rock, Ark.
Wulle, Mrs. Bernard, Indianapolis, Ind.
Umlauf, Mrs. E. C., Susquehanna, Pa.
Yochem, Mrs. Frank, St. Louis, Mo.

Applying Staybolts of All Types*

This subject is one in which every railroad man and manufacturer of boilers has the most vital interest. There is no part of a boiler which is constantly giving the user more worry and grief than leaking staybolts. It is a very difficult proposition to keep staybolts from leaking due to the many changing conditions in position of the firebox both in the firing up of the boiler and during the operation of the engine. Years of experience

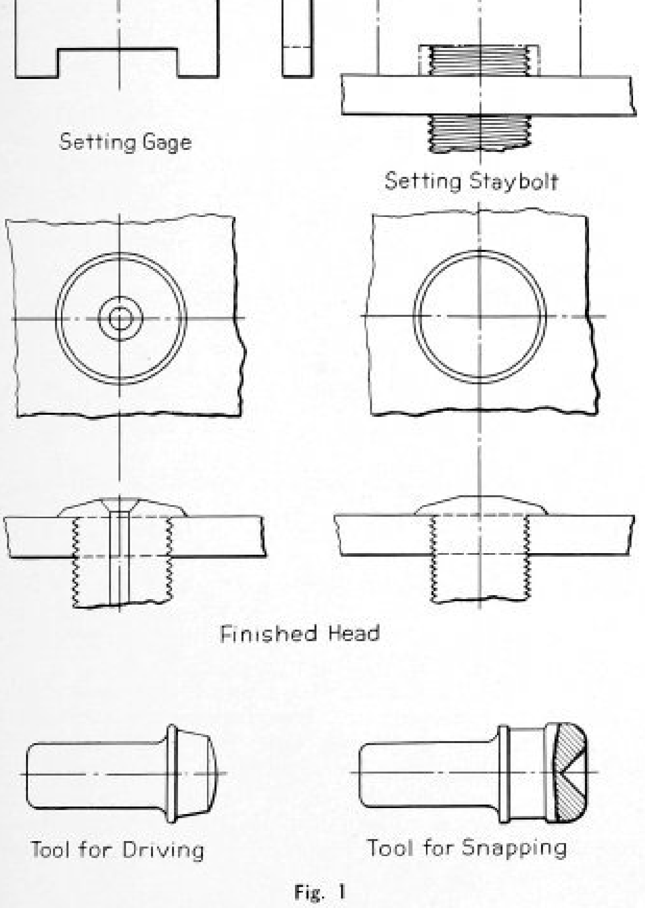

Fig. 1

have taught all those who have supervision over boilers that there are many contributing factors to this condition. Your committee has not undertaken to advance some of the reasons and contributing factors for this condition but has endeavored to determine as nearly as possible the best method of application of staybolts to boilers, thereby eliminating at least one of these factors causing leakage of staybolts.

Your committee is agreed that one of the first essential steps to take towards attaining the best possible application of staybolts is to see that each particular operation is correctly started; this applies to both old and new work. We all are aware of the fact that in designing boilers the correct staying of plates is a most important factor. Therefore if the general contour as designed is not maintained as nearly as possible mechanically and practically in forming sheets, it is a contributing cause for further trouble. The greatest of care must be taken to see that honest effort and attention be given this particular part of the work. In drilling the holes for staybolts both in outside and inside sheets, care must be taken to drill the holes sufficiently smaller in diameter than the required finish size to allow for the difference in the contour and slope of the outside and inside sheets. When holes in sheets are drilled sufficiently small to insure the absolute paralleling of holes between outside and inside sheets the possibility of securing holes with perfect threads is almost assured.

Fabrication of Staybolts

In purchasing material for fabrication of staybolts, it is absolutely essential that a sufficient allowance in diameter should be made to take care of mill variations in course of manufacture of material for staybolts. This gives assurance of fabricating bolts without having flat spots on the outside of the staybolts. In threading staybolts, a machine which is equipped with a center lead screw should be used which will insure a nearly perfect pitch and lead on the staybolts. In the threading of staybolts the ground thread chaser should be used, since a true form of thread is then assured.

After completing the operation of cutting threads on staybolts, a check should be made by use of an accurate gage, as well as a very careful inspection to avoid using bolts which show signs of seams and other similar defects; all of which would be contributing causes for leakage of staybolts.

All staybolts should be threaded to gages set to correspond with the pitch diameter of taps which are to be used. The use of ground thread taps will assure perfect tapped holes and no variation in sizes of taps. Before starting to tap holes in the sheets of a boiler for staybolts, the sheets should be straightened by the use of straight edges and held in place either by applying temporary bolts or by using stiffening bars in scattered sections of the boiler. In tapping holes, an air motor which has the least possible oscillating movement should be used. The use of an air motor of the rotary type will give better results on tapping than the piston type of motor.

In tapping holes it would be preferable to use ground thread taps but where other taps are used care should be used to gage the taps by the use of master gages and only taps which gage very nearly alike should be employed. This precaution expedites the threading and application of staybolts and assures proper fit of staybolts in holes and also increases production. The form of thread used for staybolts is probably a matter of opinion, although the majority of boiler makers prefer the U. S. form as it has proven more satisfactory in most cases in the tapping of holes and threading bolts

* This report was prepared by a committee composed of the following members: Leonard C. Ruber, superintendent, boiler department, Baldwin Locomotive Works, chairman; George M. Wilson, general boiler supervisor, American Locomotive Company; M. V. Milton, chief boiler inspector, Canadian National Railways; C. W. Buffington, general master boiler maker, Chesapeake & Ohio Railroad.

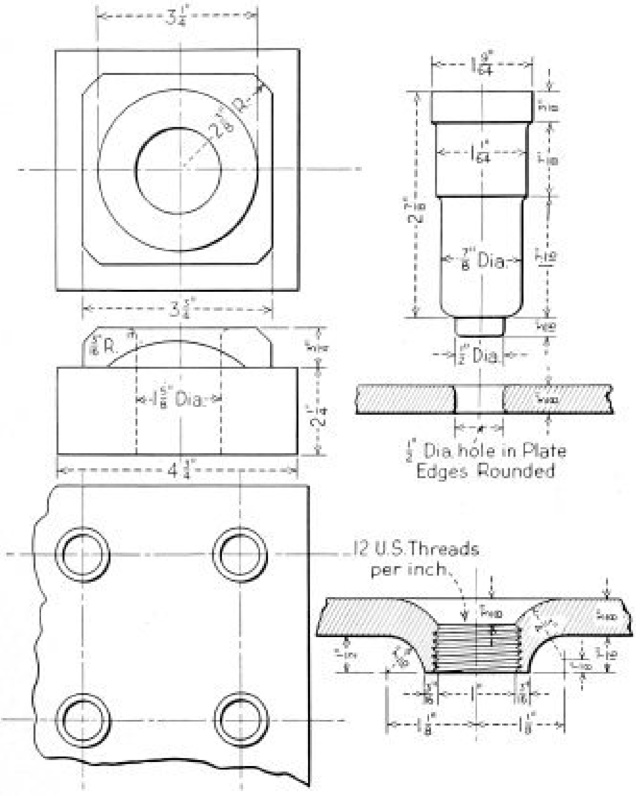

Fig. 2

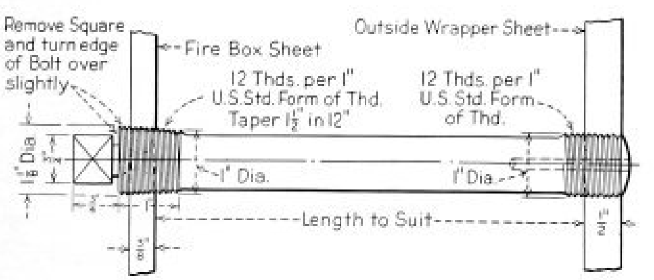

Fig. 3

and proven more economical in wear on chaser and taps.

In applying rigid and hollow staybolts in boilers, it is more desirable to apply bolts from the outside of the boiler because there is less liability of distorting the threads on the bolts. When bolts are applied to boilers there should be a reasonably tight fit of the bolts in sheets without the possibility of a movement sideways or up and down if care has been exercised as outlined.

Your committee has not attempted to discuss the questions of material, as we know there are some railroads who use steel and others iron for staybolts. Therefore in the use of the various grades of material it becomes necessary for anyone who does threading of staybolts to grind chasers to various angles and clearances which will give best results. Experiment alone is the best solution for determining the correct angles and clearances.

In tapping holes for flexible stays it is important to screw a cap or plug in the outside sleeves and in cases where no sleeves are used a bushing should be applied in the holes in the sheet, that will permit the extension on the tap to act as a guide in tapping the hole in the inside sheet, thereby giving assurance of a perfect alinement of the hole with the sleeves on the outside sheet. In the application of staybolts of the flexible type bolt there is a wide difference of opinion whether the bolts should be seated in the sleeves before they are headed over. Most boiler makers are agreed that the best results are attained by screwing the bolt up until seated and then turning the bolt back about one-eighth to one-quarter of a turn before heading over.

In the application of crown stays to the boiler, the same method of procedure should be followed as outlined for the application of water space staybolts; except, where the taper end bolt or head bolt is used a lead should always be used on taps to insure alinement. There has been a great deal said about continuous thread taps for tapping but it has been the experience of most all boiler makers that the slight movement of the sheets compensates for any difference which might be expected in tapping and applying bolts, as the sheets accommodate themselves to the threads of bolts.

In setting staybolts and crown stays, except the taper head bolt type for heading, a gage should be used which permits at least 2½ threads on the inside and three threads on the outside of the staybolts to extend beyond the sheets. In the case of taper bolts not less than four threads should be allowed over the sheets for heading bolts. Some of the railroads differentiate between allowances for extending the bolts beyond the sheets between the hollow and rigid type of bolts. On some railroads the allowance of one additional thread is made on the hollow type of bolts. The setting gage and bolt as applied are shown in Fig. 1.

The type of tools used in heading over the bolts is a matter of opinion but the type of tool most generally used is shown in Fig. 1. This illustration shows the style of snap most commonly employed in setting staybolts after heading over. There are many other types of heading tools which have been used by some railroads but your committee is endeavoring to recommend that which has proven most successful with the majority of boiler makers.

In applying staybolts to boilers which require new fireboxes or other repairs, the same procedure, if followed as outlined, will give the desired results. In cases where parts of fireboxes or new fireboxes are applied and the holes in the outside plates are ⅛ inch larger in diameter than the original required size, your committee recommends restoring the holes to the original size by two methods as follows:

1. Ream hole taper and drive into hole a taper bushing and then weld around the edge of the bushing.

2. Ream hole taper and weld hole solid, then drill hole for required size for tapping to accommodate the original size of staybolt.

The holding on of staybolts while the heading operation is being performed is important and therefore any tool which has sufficient weight to act as an anvil against which the heading tool operates is one which is most effective. Your committee therefore realizes each user of boilers has some definite method of supporting such tools and therefore we have not definitely stated any particular method of support.

For holding on flexible bolts where sleeves are used, we recommend that a cap be screwed in or on the sleeve with a hole drilled in the center through which the holding on tool passes, thus insuring direct support in the center section of the bolt during the heading operation. The type of tool generally used, which is for holding on this type of bolt, is one which is made to conform with the shape of the heads of bolts and is inserted in the main holding tool. Your committee recommended the above as standard practice of application of staybolts of the Master Boiler Makers Association.

However your committee has two new ideas which it wishes to present to the members. These ideas have been put in effect on the railroads of the members who are the fathers of the thought of this new departure for staybolt application. As these are still in the experimental stage and are apparently giving good results your committee feels these new methods should be given special attention. A report should be made of the results of these ideas at another convention so others may have the opportunity of the benefits derived therefrom.

Fig. 2 is a detail drawing of one of the new methods for staybolt application. It also shows the type of tool used for flanging operation.

Fig. 3 shows a detail of the type of staybolts as applied. This type of staybolt has a taper head 1½ inches taper in 12 inches, which is applied on the firebox end. The originator of this idea recommends the application of this type of staybolt on large size power 9 rows up from the water space frame.

In conclusion your committee has endeavored to eliminate all possible individual thoughts or methods but recommends that which the majority of members have proven to be the best methods.

Discussion

President Kurlfinke: This is the first time I ever saw a drawing covering a taper head for a staybolt. I have seen them for crown sheets. There must be some reason for it. The peculiar thing is that on our railroad we are thinking about going to a straight thread on the crown stay. As a matter of fact, we have many locomotives equipped with straight thread bolts.

G. E. Stevens (Boston & Maine): In 1929 we purchased some new locomotives. We had a great deal of trouble with leaky side sheets. I took one firebox and applied 25 staybolts with a steam-tight thread. I applied 25 with a straight thread. The steam-tight thread gave us just as much trouble as the straight type. I do not believe there is anything in a tapered thread staybolt.

L. R. Hasse (Baltimore & Ohio): Maybe the committee can explain just why this tapered thread is used.

J. A. Doarnberger (Norfolk & Western): All that I have to say on the taper bolt I said to you last year in the *Proceedings*. We have had a great deal of trouble with leaky bolts in the side sheet. There is nothing new to it. I took it for granted that we were having trouble with the tapered head bolts in the crown, and if we were having trouble there we'd have it in the side sheet. We built 20 engines in Roanoke carrying 300 pounds pressure and we had considerable trouble with them. After some eight or nine months we had trouble. The sheets were good, but we kept renewing them frequently. It was a shame to throw the sheet away, so I conceived the idea that we would enlarge the hole and put in a taper bolt. That is, use 1-inch body bolt, tapered to about 1 3/16 inch, 12 U. S. finished thread. We took out about nine rows above the mud ring. We tapped them out and we cut the squares off and lengthened the outside. We held on the inside, drove the bolt outside, took off the whiskers, as they say. We held on and all we did was just go around the edge. We made no attempt to drive the bolt at all. Since that time we have adopted it as standard.

I think the taper bolt has helped us wonderfully. I believe we are on the right track with it.

C. W. Buffington (Chesapeake & Ohio): We use a flanged hole. We have one engine that has been running about three or three and a half years—one of the largest engines in this part of the country—and the fire has never been knocked out of that engine once on account of staybolts leaking. It has run about two years to a Class IV, and the bolts that leaked under hydrostatic test were bobbed up slightly. We are well pleased with our tests so far. I really think Mr. Doarnberger has something in his idea regardless of what you people say about that, because it certainly helps to hold the sheet and you haven't much holding power there.

J. J. Welk (Wabash): Some years ago our superintendent of motive power decided to try staybolt holes flanged out or belled, as we call it, the same as shown in the sketch in the magazine. We had no luck with it. We tried only two jobs and did away with it. The sheets cracked out right in the turn of the bell or in the flange, right in the knuckle. That was done away with. We have never tried it any more.

H. J. Peters (Pennsylvania): In the last eighteen months or two years I have applied thirty sets of side sheets with flanged staybolt holes, using Mr. Doarnberger's idea of a tapered staybolt. These engines have made better than 75,000 miles. Our good friend Mr. McCune, Federal inspector, looks at them every time he comes around. We haven't had a boiler maker in a firebox on any one of those engines to put in a staybolt since we installed them.

Secretary Stiglmeier: I made a trip to Richmond to look at the locomotive having these flanged holes. The firebox that I looked at was in very good condition. There was no evidence of any checks at any staybolt hole. The staybolt holes were in very good condition.

Frank Yochem (Missouri Pacific): In 1930 we got twenty-five heavy freight locomotives, 250 pounds working pressure. They came to us from the builders with 1-inch staybolts in the side sheets. After six or eight months, the bolts started giving us trouble. We held them on the outer end and re-drove them with a No. 60 long stroke hammer. We nursed them along for twelve to eighteen months and we renewed them. We put in 1 1/16-inch bolts. This bolt did not last as long as the 1-inch bolt. We removed them, going from 1 1/16 inch to 1⅛ inch. The 1⅛-inch bolt did not last as long as the others. We renewed them and put in 1 3/16-inch bolts. The engines went into the shop after six years' service. We put in new full side sheets. We bushed all our holes in the casing sheets by tapping them out and applying 1¼-inch bushings, renewed the holes and started them out with 1-inch bolts again.

President Kurlfinke: Now, that's good. He said just exactly what I am thinking. When you do not control the size of your staybolt iron,—and I call it iron because we are used to calling it iron, not steel and iron in the true sense of the word,—we had bolts inch and and a half in diameter. That is an honest fact! So we had all kind of taps.

Now we put in the smallest size bolt we can put in a firebox. Our pressures of 200 and 210 pounds will take a ⅞-inch bolt. For 235 pounds we start at 15/16 inch, but under no conditions do we put in bolts larger than 1⅛ inches. This practice has helped us reduce expenses in the carrying of stock, also taps.

J. A. Doarnberger: You say that at a certain pitch you use 15/16 or a ⅞-inch bolts. When you raise your pressure ten or fifteen pounds more you go up to a larger bolt. On our road we have a minimum of 1-inch diameter bolt. As we raise our pressure, we shorten the pitch of the bolt. That is our standard on all new work. Over 1 inch in diameter, we reduce our pitch.

Lewis Nicholas (Monon): There is no doubt that we have all had a great deal of experience with staybolts leaking in side sheets but I believe that we have all come to the conclusion in late years that the only thing that would keep them from leaking was to keep our sheets clean. I know that was our trouble, and if the staybolts were properly applied—regardless of your system—if you have an accumulation of mud around them your sheets would crack and your staybolts would leak. Since we have been educated to the necessity of keeping our boilers clean we have practically eliminated the staybolt leakage.

H. H. Service (Sante Fe): You must not lose sight of the fact that you have a water condition to consider. I say that for this reason: About eighteen months ago we transferred one locomotive from a territory where it had never leaked. Involved in this locomotive firebox were straight staybolts in the side sheets, tapered radial stays in the crown sheet. We transferred the engine from the Southern district to the Northern district. I was asked to make an inspection after the thirty day period because of a device being applied to that particular boiler. The boiler was in service thirty days and when I went there, there was not a bolt that wasn't leaking, both tapered and straight. The scale came out of that boiler as it should for the change of the water treatment involved. I didn't know whether to condemn the device or recommend it, but it looked like I was going to condemn it. I asked for permission to have the test extended ninety days. Without touching the bolts in the ninety day period, that firebox was black. That water had built up its own scale, reduced the other scale that was in there to begin with, built up its own scale for the territory in which it was working, and our troubles ceased.

Where there is a water condition you must take it into account. Where you find black fireboxes leaking, you call for the chemist. He visits there possibly three days afterwards and finds no leaks. That goes with your straight staybolts or your tapered staybolts.

Thickness of Front Tube Sheets*

We have carefully investigated 46,697 locomotives, which is 86 percent of the 54,584 pieces of equipment in the United States and Canada, and the results indicate clearly there is still a wide difference of opinion as to what is the proper thickness for front tube sheets for locomotive boilers.

The following tabulation shows the official count as it were, of the vote:

Thickness of Front Tube Sheet	½ inch	9/16 inch	⅝ inch	¾ inch
Number of Locomotives	9806	7472	18212	11207
Proportion	21%	16%	39%	24%

In view of the relatively large number of locomotives involved in this study, it is fair to assume that a proportionate number of all the locomotives in service in the United States and Canada are equipped with the various thicknesses of sheets shown. As an illustration, there are probably 39 percent or 21,288 of the 54,584 locomotives equipped with ⅝-inch thick front flue sheets. A large number of the Administration locomotives constructed during 1918 and 1919 were equipped with front flue sheets 9/16 inch thick.

A total of 54 railroads were canvassed, replies and prints being received from each one, and in the following tabulation we have divided these roads into five groups, *A, B, C, D* and *E* as explained at the end of the table. Class *C*, as an illustration, being those roads which have more than 500 locomotives and not over 1000.

Line No.	No. of Locomotives	Thickness Front Tube Sheets	*Remarks*
1	*B*	½ inch, 9/16 inch	These tube sheets give satisfactory service. Principal difficulties can be attributed to errors in design, wherein large flues have been located too close to the knuckle. On these, some trouble has been experienced due to sheets cracking in the knuckle.
2	*C*	½ inch, 9/16 inch	The only trouble experienced has been cracking at the knuckle due to the use of ¾ inch radius. Now using 1½ inch to 2 inch radius, which increases life of sheets but sacrifices some tubes.
3	*D*	⅝ inch, 9/16 inch	Not experiencing any trouble as regards application or design.
4	C	⅝ inch, ¾ inch, 9/16 inch	No particular trouble has been experienced except cracking at the flange radius on some 85-inch diameter boilers. Advocate 1 inch or larger radius for flange.
5	*E*	⅝ inch	No comments on maintenance.
6	*D*	⅝ inch	Have trouble with cracking in the top and side of knuckles. In great many cases, repairs are made by cutting out cracked section and welding in another piece, except in cases where crack apparently is extending over too great an area. Maintenance due to cracked knuckles is considerable on large power.
7	*B*	⅝ inch	No comments on maintenance.
8	*D*	¾ inch	Experience cracked knuckles and practice is to renew bottom portion.
9	*B*	⅝ inch	No comments on maintenance.
10	*B*	⅝ inch	No unusual trouble experienced. Use as large a radius as possible in flange to prevent cracking. Never go below ¾ inch radius.
11	*E*	⅝ inch	Very little trouble experienced. Have had cases where they cracked in the radius of flange.
12	*B*	½ inch min. ⅝ inch, ¾ inch for larger locomotives	All renewals are ¾ inch on boilers 72 inch diameter or larger. The practice is to weld in new lower portion. A few replacements have been made by riveting a 1-inch by 3-inch steel ring to the first boiler course to which a new straight sheet is welded with satisfactory results, but it is not recommended in preference to a new flanged sheet if the entire old sheet including flange is removed.
13	*B*	¾ inch	Have not experienced any undue trouble. These sheets have life of 20 years or more.
14	*D*	⅝ inch	Have experienced cracks in knuckles which vary in length from 4 inches to 50 inches.
15	*D*	⅝ inch	Have not experienced any trouble as regards design.
16	*C*	¾ inch	These sheets are satisfactory.
17	*D*	½ inch, ⅝ inch	Generally renew sheets after about ten years due to cracked knuckles, which take place on the sides and do not extend to the bottom center line and very seldom in the top portion of the sheet. In one district where hot water is used for filling have not experienced any cracked knuckles in 13 years' service.
18	*D*	⅝ inch	Have had some trouble with this design. Have taken no steps to overcome.
19	*B*	⅝ inch	Now use 1-inch radius for flange; previously used ⅝ inch which gave trouble due to cracking.
20	*B*	⅝ inch	Have had some trouble with cracked knuckles below the tubes and make repairs by cutting out the bottom portion of the sheet and welding in new disk. Old flange is not removed from the shell.
21	*E*	⅝ inch, ¾ inch	After flanging, the flue sheets are thoroughly annealed.
22	*C*	⅝ inch	Have checks and cracks in the roll of the flange on the bottom which is due to age. Get about ten years' service before cracking develops. Bottom portion of sheet is renewed by applying a patch, riveting the flange on the bottom and welding across the bridges between second and third rows of flues.
23	*B*	½ inch, ⅝ inch, 9/16 inch	Considerable trouble with cracking of sheets at the knuckle in larger engines. Patches are welded in place. Only the section containing defects is renewed. All sheets are flanged hot, annealed and drilled.

A—Over 2000 locomotives.
B—1001 to 2000 locomotives.
C—501 to 1000 locomotives.
D—251 to 500 locomotives.
E—250 locomotives or less.

* This report was prepared by a committee composed of the following members: Walter R. Hedeman, assistant mechanical engineer, Baltimore & Ohio Railroad, chairman; C. A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis Railroad (Big Four); E. C. Umlauf, supervisor of boilers, Erie Railroad; R. A. Pearson, general boiler inspector, Canadian Pacific Railway.

Line No.	No. of Locomotives	Thickness Front Tube Sheets	*Remarks*
24	*D*	½ inch	Have had no trouble whatsoever with front flue sheets, either from maintenance or installation. The present practice is considered entirely satisfactory.
25	D	⅝ inch	Do not experience any particular trouble except now and then find that sheets crack in the knuckle usually at the side close to the top row of tubes, and about 10 inches to 14 inches long.
26	*B*	¾ inch	No trouble except from corrosion.
27	*E*	9/16 inch	Have experienced no unusual trouble with this application.
28	*D*	⅝ inch	No comments on maintenance.
29	*C*	⅝ inch, 9/16 inch	Not experienced any unusual difficulty with this design.
30	*C*	¾ inch	They rivet a ring to the shell to which the flue sheet is welded and reinforced with a series of gussets. Has been standard practice for quite some time and find it extremely satisfactory; has eliminated cracks in the flange knuckle.
31	*C*	¾ inch	Previously used ⅝-inch thick sheets which only runs from 5 to 7 years when cracking would start. By changing to ¾ inch the sheets would run for indefinite period. 1 inch radius has proved the best, the 1¼ inches being more susceptible to early cracking.
32	*D*	¾ inch	The ½-inch and ⅝-inch sheets proved too light for service demanded and ¾-inch thickness was adopted as standard for all front flue sheets. This was 13 years ago and since that time flue sheet trouble has been at a minimum. All sheets are normalized at 1625 degrees F. which prolongs the life and relieves strains set up in flanging.
33	*E*	⅝ inch	Have not experienced any particular difficulty with this application.
34	*C*	9/16 inch	Sheets are cold flanged and annealed at 1500 degrees F. Find this method to be the best after tests of various methods.
35	*A*	½ inch, ⅝ inch	Have experienced trouble with front flue sheets when flanging cold with McCabe flanger. However, this was overcome by heating sheets to proper temperature and then hand flanging. Trouble was experienced with cracked knuckles. This was corrected by increasing radius of knuckle to 2 inches. Have applied ¾-inch front tube sheet to one Mikado, which has given 10 years service without trouble.
36	*A*	9/16 inch	No comments.
37	*D*	¾ inch	Only trouble is on Texas and Mountain type engines which develop cracked knuckles at lower portion of sheet. They apply new lower portion by welding.
38	*B*	⅝ inch	No comments.
39	*E*	½ inch, 9/16 inch	Principal trouble cracking at knuckle where flange radius begins. Attempted to correct by increasing thickness of sheet. Also welding in flat tube sheet to a circular ring which serves as a flange. Some improvement but trouble not entirely eliminated.
40	*C*	⅝ inch, ¾ inch, 9/16 inch	No trouble with application or design.
41	*E*	½ inch	Have had some trouble with front flue sheets buckling. Feel that ¾-inch thickness is about right.
42	*E*	½ inch, ⅝ inch	No comments.
43	*E*	¾ inch	Sheets flanged cold and annealed at 1650 degrees F. In winter time sheets are heated to about 900 degrees F. before flanging. New bottom portions are applied by welding.
44	*A*	½ inch	They use 2-inch radius for the flange and a separate short course is provided for the front tube sheet. They have some trouble with front tube sheet cracked flanges at the bottom in boilers with 2¼ inches diameter flues 19 feet long. These cracks start at the bottom, and extend sometimes as far as center line of boiler on either side. They tried a buckle in the bottom part of the sheet, but the trouble has not been eliminated or very materially reduced.
45	*D*	⅝ inch	They anneal their sheets before flanging, after which they are again annealed and straightened and flue holes drilled.
46	*E*	⅝ inch	Have experienced cracks in flange radius on some engines. Have applied gusset to the flange of the front flue sheet, also applied scalloped flanged patch to bottom and sides for repairing where knuckles are cracked.
47	*C*	¾ inch	No comments.
48	*D*	¾ inch, ⅝ inch	No trouble experienced.
49	*A*	9/16 inch, ⅝ inch	No trouble experienced.
50	*B*	½ inch, ⅝ inch	At one time ¾-inch plate was used for front flue sheets, but due to frequent crackings of bridges, the thickness of plates was reduced. At present are not experiencing any trouble with flue sheets.
51	*D*	½ inch, ⅝ inch, 9/16 inch	No comments.
52	*E*	⅝ inch	Have some defects, that is, grooving and cracking in the heel of the flange on the water side. Most frequently at the sides rather than at top or bottom. Usually takes 8 to 12 years to develop. If thicker sheets were used they may be found too rigid and probably cause or aggravate grooving conditions, particularly in new boilers.
53	*C*	9/16 inch, ⅝ inch	Sheets are flanged cold. Principal defects are bulging, corrosion, cracked bridges. On an average renew about 5½ sheets per year. Many locomotives dismantled during the past several years still carrying original tube sheet, or sheet applied at time locomotives were superheated.
54	*C*	½ inch, ⅝ inch ¾ inch, 1 inch	The thickness of sheet varies according to boiler pressure, boiler diameter and length of flues. Have some trouble with cracked front tube sheet flanges and broken bridges. Contributing factors being various diameters of boilers, length of flues and tubes, expansion and contraction and steam pressure carried. These are breaking-down factors.
55	*A*	¾ inch	Have trouble with cracks in flanges usually found in knuckle from bottom up the sides to about on line with top of the tubes, always on water side. New bottom sections are welded in.
56	*E*	¾ inch	Adopted this thickness 15 years ago. Previously used ½ inch, latter gave trouble due to cracked knuckles, and bulging.

It will be noted under *Remarks* that the most prolific source of trouble with front flue sheets is cracked knuckles, and apparently this exists on all thicknesses of sheets in use. In some cases this has been attributed to the radius of the knuckle, the claim being made that the larger the radius the less liability of fracture, though this is only accomplished by a reduction in the number of flues.

In several cases the sheets are annealed before and after flanging, in one case sheets are heated and hand flanged. No doubt some of the cracked knuckles are due to the manner in which the sheets are handled in flanging, and we feel that hot flanging is superior to cold flanging, though in both cases it would be an advantage to anneal the sheets.

It would be ideal if the conditions which give rise to the problems of front tube sheet failures could be altered definitely, but due to the many diameters of boilers, lengths of flues and tubes, expansion and contraction, and steam pressures carried, these are the breaking-down factors bringing about leaking flues and tubes, cracked front tube sheet flanges and broken tube sheet bridges.

It is quite evident from the information collected that the proper thickness for front tube sheets is still undetermined, or more or less in the experimental stage, therefore, we hesitate to make any definite recommendations as to any single thickness for all boilers.

It might be well for this same committee to continue the study of this subject for another year, submitting definite questionnaires to the general boiler foremen of the various roads to try and bring out conclusively from which thickness sheets the best results are being obtained, and from this information we might be in a position next year to give a definite recommendation for the proper thickness of front tube sheets for the various diameter boilers, taking into consideration length of flues and boiler pressure. The handling of the sheets and the material specifications entering into the manufacture would also be given consideration.

Discussion

F. A. Longo (Southern Pacific): I would like to ask a question of any members using the three-quarter flue sheets,—whether they are having more trouble on the back flue sheets with knuckles cracking.

Frank Yochem (Missouri Pacific): We have some 250-pound engines, purchased some years ago, equipped with ⅝-inch front flue sheets. When we shopped the engines we found the knuckles cracked on the right and left sides as well as the back flue sheet. The back flue sheets were ½ inch. They were cracked in the combustion chamber engines.

We welded the cracks on the water side and applied a cover patch on the smoke side and when the engines were shopped the second time we renewed the sheets and put in ¾-inch front flue sheet. Our standard on the railroad is "all boilers under 60 inches in diameter ⅝-inch front flue sheets; everything over 60 inches in diameter, ¾-inch front flue sheets. The latter is very satisfactory.

G. E. Stevens (Boston & Maine): In 1928 we had twenty locomotives built with ⅝-inch front flue sheets. In about two years the front flue sheet began to crack at the knuckles, on each side about half way up. I think that at least 7 percent of these locomotives have had patches on the knuckles. Sometimes the trouble is on the right side, sometimes on the left side. That is a ⅝-inch sheet.

J. A. Doarnberger (Norfolk & Western): In all our high-pressure engines (we carry three hundred pounds per square inch pressure) we use a ¾-inch front flue sheet. Our reason for using this is to get a good hold between the bridges. We put in 5½-inch A-type superheater flues. Another thing, sheets hold their shape better. When we get them we put a strong back on them and heat them and pull them up. If the knuckles are cracking, there is only one thing to do; stop flanging the sheet. We have 250 odd mallets over half carrying 300 pounds pressure; they have no knuckle to crack, nor do we have any welding to break loose and develop cracks.

President Kurlfinke: Those are exactly our sentiments on the Southern Pacific. We had ½-inch sheets. They gave us all kinds of trouble. They were putting them in when the boss took one of his trips. He saw a whole gondola full of front tube sheets and wanted an explanation. The result was that I am doing just exactly what John Doarnberger is doing. We have gone from a ½-inch sheet to a ¾-inch sheet. With those ½-inch sheets we found that we were cutting the tubes in two even in rolling them. We didn't have the bearing surface. We experimented a little while on that because some of the boys were interested, and we commenced to put shims in them. In a way they were good, but they didn't last, so the ultimate was to put in a heavier sheet. Then the flanging question came up. We are now using a flat front tube sheet supported by a ring with corner gusset braces. It has not affected the back tube sheet. Our tubes in these engines are 24 feet long. We figure they get a big enough sag; that the front tube sheet being heavy does not take the expansion that the ½-inch sheet did. Naturally, we expected that all the stress would go on the knuckle of the back tube sheet but to our surprise we find that we do not have any trouble. On our road, I am in favor of applying a ¾-inch sheet and not flanging them or riveting them in.

Frank Yochem (Missouri Pacific): We all know that one of the things that warps a front flue sheet is over-rolling of the tubes, especially superheater tubes, because we have to roll them awfully heavy to make them tight in the front flue sheet. After all the tests, we have some small leaks. We work from the center both ways. We have created in the rolling a certain amount of slack or excess rolling that we work over to the sides. On a flanged sheet, the knuckle will absorb a certain amount of slack that we push over to the side. Now, where you put in a flat front flue sheet that is not flanged, by the welding method, do you find that sheet will warp more excessively than a flanged sheet?

J. A. Doarnberger: I can not say. As I said here before, our reason for applying the three-quarter sheets was to stop the movement, the buckling and warping. But the greatest thing we did, was trying to get a heavier bridge and a longer recess for the flue; in other words, strengthen the bridges.

Frank Yochem: We got some engines six years ago from the builders, in which the front end flue sheets were pressed by the builder while hot. The back flue sheets were pressed hot. The engines operate under 250 pounds pressure-passenger engines. After 30,000 miles we had to renew the top knuckle of the back flue sheet. These sheets were flanged hot by the builders, no doubt under a press. We flanged those back sheets when we renewed them, when we shopped the engines for the flues—Class III repairs. We flanged them cold under the McCabe flanger and we got better service out of them than we did originally from the hot pressed sheets from the builder.

Sigurd Christopherson (New York, New Haven & Hartford): We have fifty Santa Fe's on our railroad. Previous to the siphon, in our engine houses there was continual patching of back flue sheets. Since we applied the siphons eight years ago, we have not applied one patch to the top of the back flue sheet.

Frank Yochem: We get better service out of our back flue sheets in fireboxes that do not have a combustion chamber than we do with the combustion chamber engine. In other words, the knuckle lasts longer than it does in the combustion chamber engines.

E. H. Heidel (Milwaukee). Practice on the Milwaukee has been a ¾-inch front flue sheet for boilers over 70 inches in diameter. We do experience trouble with cracks in the flange. That is not due, however, to flue sheets that have been in service for four or five or six years. The flue sheets that we have trouble with cracking in the flange are sheets over ten years old.

C. A. Harper (Big Four): As a member of the committee, which will have to make a report next year, I wish to ask you that as locomotives go through your shop and you find cracked flue sheets, it would take only a few minutes to tram your boiler and see just how much your boiler is out of round. I think the boiler being out of round has quite an effect on the flanges of the flue sheets.

There is another thing we have to take into consideration and that is materials. In visiting some of our steel mills I have actually seen test pieces taken from sheets of steel which the railroads buy that have a variation of from six to fourteen thousand pounds in tensile strength between one side of the sheet and the other. In flanging sheets, I wish you would state how you normalize them, because a fair steel, if properly normalized, can be brought back nearly to its original state. It would be well also to give consideration to the length of flues in the flue sheets. If some of you men will pay attention to those little points in giving us replies from which to compile a report, it will be very helpful to us.

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Reg. U. S. Pat. Off.

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Contents

Boiler and Tender Pitting and Corrosion

(Continued from page 275)

contribute as freely as they do here to that necessary interchange of opinion.

Mr. McBride (Denver & Rio Grande): First, from the boiler makers' standpoint there is one thing that should be brought out to which I do not think many roads or boiler makers or mechanical engineers have given consideration. We have specifications on the boiler steel for certain ranges. We purchase that steel and have it shipped to us and we pay no attention to how it goes into the boiler or firebox.

For example, suppose we have a side sheet with a lower limit of carbon, say around ten to twelve carbon. Then we buy a firebox steel of an upper limit that is stored and it is twenty carbon, and we place that twenty carbon in the crown sheet. Then we have strain corrosion and stress corrosion take place and we wonder why.

Automatically, in placing in service steel with those variables of analysis and with the flexing that takes place in the firebox, strains are set up and those strains must centralize or localize at some point. We have found that they will localize in the sheet of the highest carbon composition.

In other words, it may be well in locating sheets, to desire, that they should be either of high carbon content or of low carbon content or else that the specifications be so revised that there will not be the variables allowed in the carbon composition.

Another thing that we have been interested in on our road is to develop some practical means for extending the life of the fireboxes. Heretofore it has been more or less a matter of guess. We have recently made physical analyses or tests on fireboxes of different ages of steel and we find this:

That it will probably be possible by means of physical analyses roughly to estimate the life of a firebox steel. For example, you find some steel after six or seven or eight years of service with the original yield point of 50,000 pounds and after some years from fifty to fifty-five thousand pounds. The ultimate has been made the same as 57,000 pounds. There is a spread there of five or six thousand pounds.

This steel is brittle, like glass. It will not withstand shock. It may look perfectly safe but if any load is placed on it, cracking immediately takes place. Not only this, but wherever we find strain cracks, strain corrosion cracks, usually associated with them is this yield point.

So far, to collect samples, we have had to cut them out and patch them or else we have used steel which has been taken from fireboxes that have been removed.

Along this same line tests on firebox steel from different roads indicate that the more the boiler is washed, the greater we increase the yield point. We can take the same steel with that high end point of 51,000 pounds, normalize it in the furnace and restore practically the original properties.

This increasing yield point also applies to boiler barrels the same as it does to firebox sheets. It is very possible that some practical means such as this can be worked out that you will be able roughly to estimate the life of fireboxes by their physical properties after they have been in service a certain number of years.

C. R. Knowles (Illinois Central): I do want to take this opportunity of commending the committee upon its very excellent report. The striking thing to me is that they have brought out in the report the importance of considering stresses. That has also been brought out by several speakers in connection with extending locomotive runs.

I wish to point out, however, that extending locomotive runs is not always a palliative in pitting or corrosion because on our railroad we have found the opposite the case. Extended locomotive runs and extended washout periods help boiler conditions through the fact that the stresses and strains set up by frequent washings, frequent cleaning of fires, cooling down of the engine are reduced.

However, there are conditions, as for example between Chicago and Memphis, where we had no pitting condition whatever on the shorter runs but the extended runs, with mixture of the various waters, did set up a corrosive condition that was rather difficult to contend with.

Another thing that I wish to dwell on is the fact that the railroads, the boiler men and everybody concerned with the operation of a locomotive are becoming treatment conscious. It has been my privilege to follow that water treating game from its infancy, that is, from the early part of the nineteenth century. In 1900 few railroads knew what was causing the leaking. I remember in 1902 when a roadmaster on one of our Western Lines complained to the superintendent that a switch engine operating in the yard was leaking so badly he couldn't keep the switches open in the winter time. That's a fact! And nobody seemed to know what caused it.

I remember the first time I ever attended one of your conventions. I believe it was in Buffalo. There was rather a spirit of antagonism, certainly not the spirit of co-operation that exists today. I just want to congratulate you and congratulate the water men upon the fact that there is the utmost co-operation between the boiler man and the water man,—which is as it should be.

Assistant Manager for Division of Republic Steel

Frank P. McEwen, formerly southern sales manager of Oliver Iron and Steel Corporation, has been appointed assistant manager of sales, with headquarters in Cleveland, of the Upson division of the Republic Steel Corporation, according to an announcement by N. J. Clarke, vice-president in charge of Sales. This division is concerned with the manufacture and sale of bolts and nuts.

Boiler Maker and Plate Fabricator

Educating the Heavy Plate Industries

Today the branches of the heavy plate industry served by this publication have come a long way back on the road to a level of normal and profitable production. This applies equally well to the locomotive construction and repair branch, to the power boiler, and to the plate fabricating sections.

Every succeeding week during the past few months has witnessed an ever-increasing demand on the motive power of the country, with the result that repair and maintenance operations on every important railroad have been speeded up. New locomotive orders have commenced to come in at a rate not experienced in years.

Through the year the curve of power boiler production has been steadily going up, while with the exception of a single month, the demand for heavy plate products from a wide range of industrial concerns has mounted to a new high level. A review of production in these various branches is given on this page.

Here then is a concentrated industry made up of three branches, all of which utilize practically the same material, tools and equipment. Furthermore the methods and processes utilized in fabricating the products of all branches is practically the same. Coverage in the field with practical information concerning these elements is very broad, insofar as heavy plate work, is involved, since readers of this publication are not concentrated in any one branch but come from a widely diversified group of companies engaged in highly individualized activities in each of the three divisions.

Boiler Maker and Plate Fabricator thus fulfills the important function of co-ordinating and disseminating knowledge of new developments in materials, tools, equipment and methods throughout the field. The activities and advances in one branch are made available to all the others simultaneously, since similar manufacturing and fabricating problems occur in all three.

For example, no industrial group in the country depends to any greater extent on the developments in the fusion welding art in all its phases than the heavy plate fabricating field. Applications covering the wide variety of materials and methods, the equipment used and the results obtained are regularly described. Information concerning welding regulations such as those published in this issue, which outline the qualification tests for welders as prescribed by the Bureau of Marine Inspection and Navigation, may consistently be found in our pages. Whether it is a new material or a new process, attention of the entire field is attracted to it through the medium of this publication.

By concentrating on the practical phases of each branch and by being able to interest not only the executive and designer but the superintendent, the foreman, and on down to the shop staff, which makes the actual application of material with the tools called for, Boiler Maker and Plate Fabricator fills an educational need not excelled by publications in any field.

This all points to an opportunity within the reach of the entire supply industry, serving any or all of the heavy plate branches; namely, that of utilizing the pages of this publication intensively to cultivate the field.

If an outstanding application of the products of any company concerned in locomotive boiler, power boiler, pressure vessel or other heavy plate work is made that would be of interest to our readers, space is available in which it may be described. This applies to methods, materials, tools, or any other type of information which serves an educational or instructive purpose.

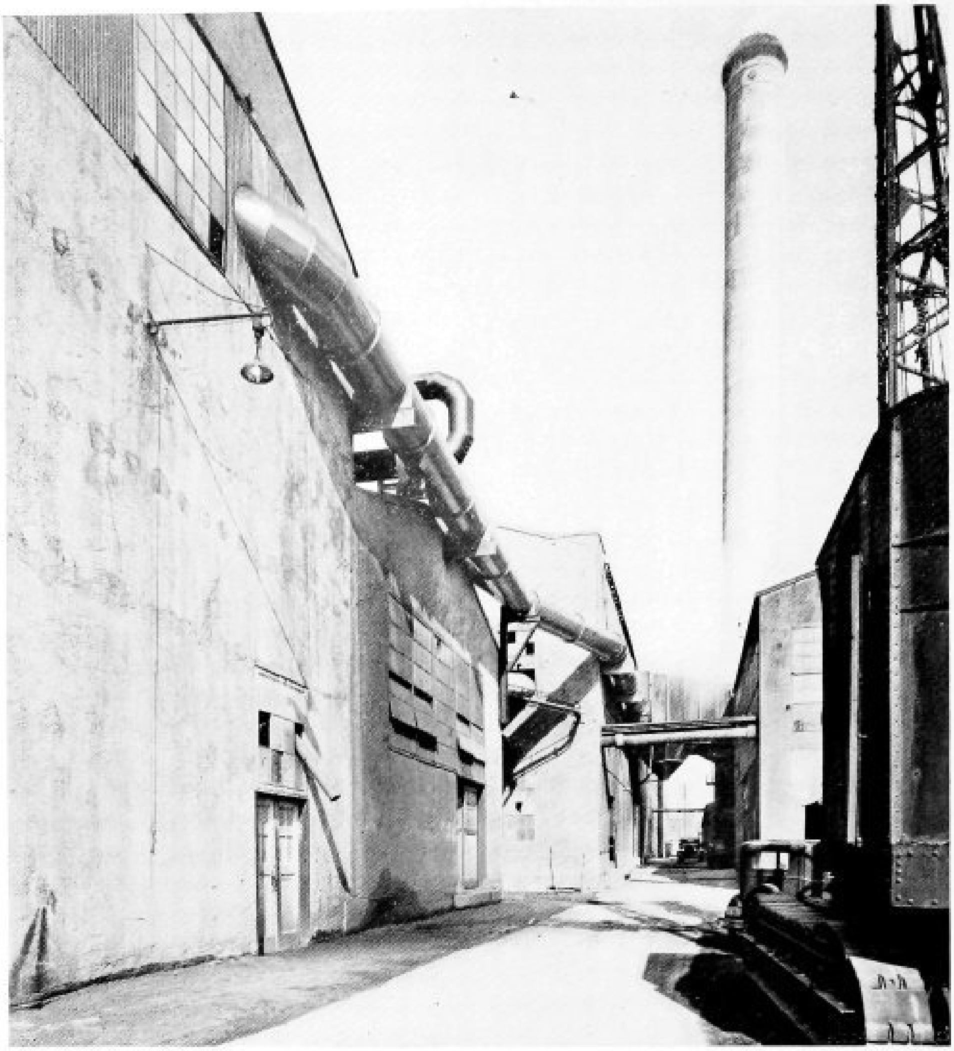
Locomotive Purchasing Shows Rapid Increase

The month of October saw the placing of orders for 21 steam locomotives among the principal builders, exclusive of new units constructed in railway shops. This brings the total number of steam locomotives ordered in the first ten months of 1936 to 143. Since November 1 the Union Pacific has placed orders for 20 more locomotives. In 1935, during the same ten-month period, 28 locomotives were ordered which represents a little less than one-fifth of the orders of the current year. Greater appreciation of the degree of recovery that has taken place in the locomotive construction field can be felt when comparison with the orders of the entire four-year period of 1932 to 1935 shows that more units have been contracted for in the first ten months of this year than the entire four years of economic depression. While these returns represent actual business in the hands of manufacturers, inquiries are outstanding for 122 more steam locomotives for domestic service and 13 for export.

Boiler and Plate Industries Improve

A review of statistics compiled by the Bureau of the Census, Department of Commerce, in regard to the activity in the steel boiler industry, shows a degree of increase during the first nine months of the year that has not been equaled since before the depression. The months of June, July, August and September saw more than a thousand units ordered for each month. From January to September, a grand total of 7848 steel boilers of all types were ordered as compared with 5071 in the same period of 1935 and 3535 in 1934. This represents an increase of 54.5 percent from 1935 and 122 percent from 1934. A comparison of totals given in square feet of heating surface reveals percentage increases of 83.3 percent and 130.2 percent from 1935 and 1934, respectively.

A similar survey of the fabricated steel plate field shows the same encouraging outlook. During the first nine months of 1935, 356,107 short tons of plate were ordered as compared with 173,085 and 182,757 short tons ordered in the same periods of 1935 and 1934, respectively. The monthly orders in May, June and July averaged over 50,000 tons per month, a figure unequaled for over four years. A breakdown of the figures shows that tank cars, blast furnaces, refining equipment and oil storage tanks were the greatest contributors to this substantial recovery.



All welded wrought iron boiler breeching

WELDING WROUGHT IRON

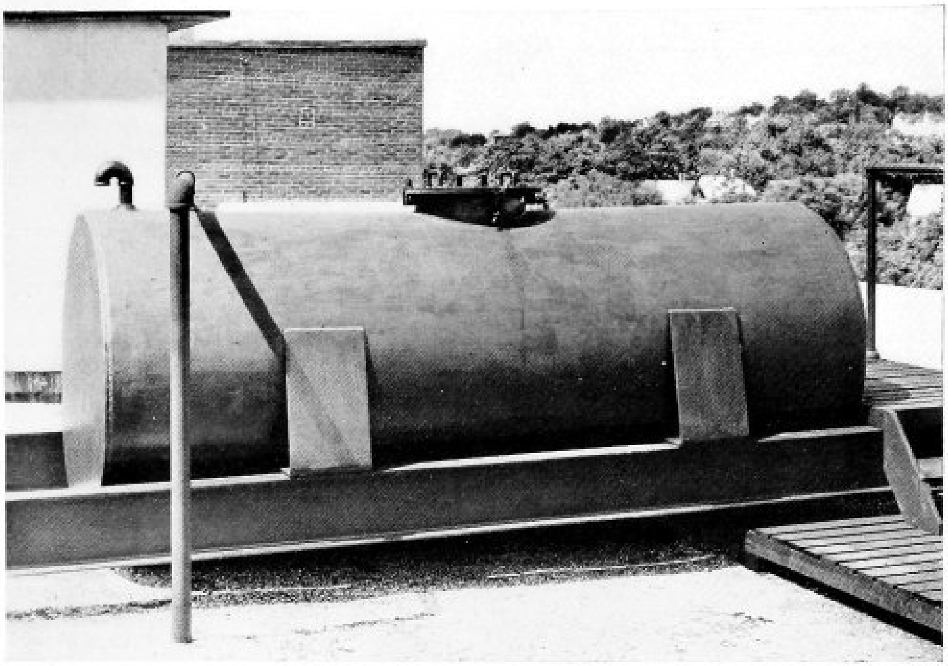
The rapid increase in the utilization of wrought-iron products for various applications where fabrication is accomplished by welding and the fact that wrought iron differs both physically and chemically from other ferrous metals suitable for welding, have made it desirable to establish recommended procedures to follow when welding wrought iron by the commonly used processes. Wrought iron is easy to weld but in order to obtain the best results both the welding engineer and the operator should be thoroughly familiar with the material and its characteristics which influence weldability.

Wrought iron is a two component metal consisting of high purity iron base metal and iron silicate. The iron silicate is a glass-like slag. These two materials are in physical association, as contrasted to the chemical or alloy relationship that generally exists between the constituents of other ferrous metals.

The iron silicate or slag content of wrought iron varies from about 1 percent to 3 percent or 3½ percent, depending upon the type or class of product. In the form of plate, for example, it usually amounts to about 3 percent by weight. This constituent is distributed throughout the iron base metal in the form of threads or fibers which extend in the direction of rolling. The slag fibers are distributed so thoroughly throughout the iron component that there may be 250,000 or more to each cross-sectional square inch of finished material. This confers on the material a definitely fibrous structure which can be observed readily if a piece is nicked and fractured.

Each of the two dissimilar materials that go to make up wrought iron has its own fusion temperature. The iron base metal, because of its low metalloid content, fuses at a temperature of about 2730 degrees F., which

Welded wrought iron syrup tank, 4 feet in diameter and 10 feet, 6 inches long installed in a candy factory



is somewhat higher than the melting point of low and medium carbon steels. The slag component fuses at temperatures between 2100 and 2200 degrees F., or several hundred degrees lower than the base metal.

The purity of the base metal gives wrought iron the ability to withstand higher temperatures than other ferrous metals and, in general, it should be worked hotter for best results. Also, the protection afforded the metal during heating by the fluxing action of the slag has a beneficial effect in producing sound welds. This is a particularly important factor in making plastic welds.

Processes and Procedures

Wrought iron can be welded easily by any of the commonly used processes, such as forge welding, electric resistance welding, electric metallic arc welding and gas or oxy-acetylene welding. The first two, of course, come under the classification of plastic welding, while the latter two are classed as fusion processes.

Plastic Welding.—When welding wrought iron by either the forge or the electric resistance methods, the important point to keep in mind is that the metal must be worked somewhat hotter than steel. In forge welding, for example, wrought iron is worked at what is termed a "sweating heat," which corresponds to a temperature of about 2500-2550 degrees F.

Plastic welding has been employed for many years with wrought iron. In fact, all standard wrought-iron pipe and a majority of the large O. D. wrought-iron pipe is produced by forge welding, which embraces both roll and hammer welding. Resistance welding has been employed in fabricating wrought-iron installations.

Wrought iron pipe fabricated from ⅜-inch plates by manual metallic-arc welding for intercepting sewage system

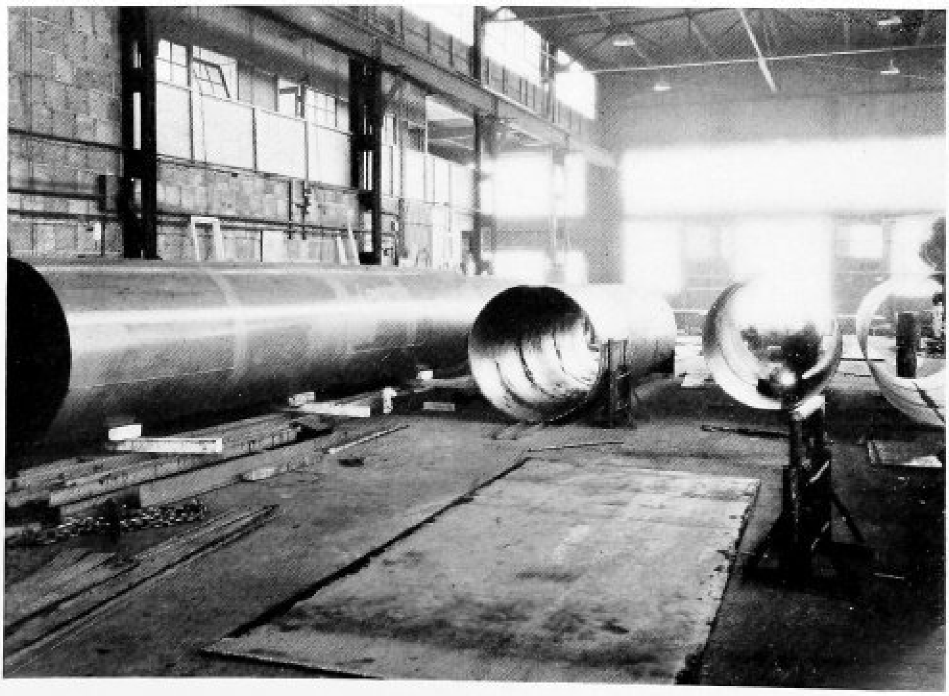


TABLE 1.—MANUAL OXY-ACETYLENE WELDING PROCEDURE

Thickness of plate, inch	1/8	1/4	3/8	1/2	5/8	3/4	7/8	1
Type of joint	Single V							
Angle (from perpendicular), degrees	30	40	40	40	40	40	40	40
Included angle, degrees	60	80	80	80	80	80	80	80
Spacing between edges (starting end), inch	1/32	1/16	1/16	1/16	1/16	1/16	1/16	1/16
Spacing between edges (18 inches from starting end), inch	1/8	3/16	1/4	1/4	1/4	1/4	1/4	1/4
Diameter of filler metal—(first side), inch	1/8	3/16	1/4	1/4	1/4	1/4	1/4	1/4
Diameter of filler metal—(root side*), inch	1/8	3/16	3/16	3/16	3/16	1/4	1/4	1/4
Tip size†	6	8	9	10	11	12	12	13
Oxygen pressure,†pounds per square inch	12	16	18	20	22	24	26	28
Number of layers—first side	1	1	1	2	3	3	4	5
Number of layers—root side*	1	1	1	1	1	1	1	1

*When a double weld is required, as for example under the A.S.M.E. Code, Par. U-68, or U-69, a root Bead is used.

†Tip sizes and oxygen pressures are for Oxweld blow pipe No. 17. The acetylene pressure may be any value from zero to 5 pounds. For other types of blow pipes use the tip size, oxygen and acetylene pressure recommended for steel of the same thickness.

Fusion Welding.—Oxy-acetylene and electric metal arc welding are the two most generally used fusion processes. Successful welding with either process is accomplished only by following carefully the correct procedure. This is true regardless of the type of metal to be welded. Furthermore, the exact procedure used with one metal may not produce the best results if used with a different metal.

Although both the oxy-acetylene and the electric metal arc processes have been employed extensively in making welded wrought-iron installations, very little research work was done until recently to establish the details of the procedure to follow in each case. A comprehensive series of tests was completed a short time ago and the results are given in the following portion of this article.

The rapid increase in the use of wrought-iron plates for marine equipment led the American Bureau of Shipping and Lloyd's Register of Shipping to conduct a series of tests to determine whether or not wrought iron would meet the welding requirements established by each organization. These tests involved fusion welding of wrought iron to wrought iron and wrought iron to steel. As a result both organizations have approved the weldability of wrought-iron plates.

Manual Oxy-Acetylene Welding Procedure.—The procedure for welding wrought iron by the manual oxy-acetylene process is practically the same as that followed in welding mild steel of the same thickness. However, one important point to keep in mind is that the iron silicate or slag included in the metal melts at a temperature which is below the fusion point of the iron base metal. The melting of the slag gives the surface of the metal a greasy appearance. This should not be mistaken for actual fusion of the base metal, and, therefore, heating should be continued until the iron is fully melted.

The best oxy-acetylene welds are produced when perfect fusion is obtained without excessive mixing of the parent metal with the weld metal. Too much rubbing or agitation of the molten metal causes the formation of oxides which may be trapped in the weld. Ordinarily, just enough of the parent metal should be fused to provide a sound bond with the filler material.

The selection of welding rod material is important. It is advisable to use a rod that has a yield point near that of wrought iron (27,000 to 30,000 pounds per square inch) and to avoid rods containing high carbon or alloys intended to increase the yield strength. In general, any high quality low carbon rod will give entirely satisfactory results.

Table 1 gives the essential details of the procedure to follow in manual oxy-acetylene welding of wrought iron. This procedure was found to produce welds of a quality to conform to the X-ray requirements of the A. S. M. E. Boiler Construction Code for Class I welds. However, other procedures may be employed that should produce welds that are just as satisfactory.

Manual Metallic Arc Welding Procedure.—In welding wrought iron by the electric metallic arc process the best welds are produced when the welding speed is decreased slightly below that used for the same thickness of mild steel. This procedure is desirable because with reduced speed the pool of molten metal immediately following the arc is kept molten for a longer period of time, thus making for more complete elimination of the gases and affording the entrained slag an opportunity to float out of the weld metal.

Also, it may be necessary to employ a slightly lower current value than that used with the same thickness of mild steel, particularly in welding thin sections where there is a possibility of burning through the material.

TABLE 2.—MANUAL METAL ARC WELDING PROCEDURE

Thickness of plate, inch	1/4	3/8	1/2	5/8	3/4	7/8	1
Type of joint	Single V	Single V	Single V	Single U	Single U	Double U	Double U
Angle (from perpendicular), degrees	30	30	30	9	9	9	9
Included angle, degrees	60	60	60	18	18	18	18
Radius, inch	None	None	None	1/4	1/4	1/4	1/4
Tongue, inch	0 to 1/16	0 to 1/16	0 to 1/16	3/32	3/32	3/32	3/32
Spacing between edges, inch	5/32	5/32	5/32	None	None	None	None
Number of passes	3	4	5	6	8	9	10
Diameter of electrodes, inch	5/16	5/16	3/16	3/16	5/16	3/16	5/16
Amperes	170	170	180	180	180	180	180

Excessive penetration into the face of the parent metal should be avoided. The penetration should be no greater than that required to obtain a sound bond between the deposited metal and the parent metal because fusion of an excess quantity of the parent metal tends to carry slag into the weld metal.

In metal arc welding, as in gas welding, the choice of filler metal is important. Any good quality rod either coated or bare can be used with wrought iron, but in general the coated rods are used more extensively in current installations.

The welding procedure found to produce very sound welds is given in Table 2. Other procedures may give equally satisfactory results. For certain classes of work where a greater degree of porosity may be permitted, larger electrodes, higher currents and higher speeds may be used.

Table 3 gives the recommended rate of travel of the electrode in inches per minute that was found to produce good results. With manual operation it is practically impossible to maintain accurately a given speed, but the proper rate can be closely approximated by timing the actual rate of travel with a stop watch and then making any adjustments necessary.

TABLE 3.—MANUAL METAL ARC WELDING
RECOMMENDED RATE OF TRAVEL OF ELECTRODE IN INCHES PER MINUTE

Plate thickness, inch	1/4	3/8	1/2	5/8	3/4	7/8	1
First layer—first side	8	8	7	7	7	6	6
Intermediate layers—first side	5	5	5	5	5	5	5
Last layer—first side	5	5	4	4	4	4	4
First layer—second side	5*	5*	4*	4*	4*	6	6
Intermediate layers—second side						5	5
Last layer—second side						4	4

*Not used unless a double weld is specified.

In manual metal arc welding, as in gas welding, it was found that welds of a quality to conform to the X-ray requirements of the A. S. M. E. Boiler Construction Code for Class I welds can be made in wrought iron.

The Chief Federal Inspector Outlines

Reasons for Locomotive Inspection*

By John B. Hall †

One of the most important duties of the Bureau of Locomotive Inspection is the investigation of accidents. I shall endeavor to show by actual figures how accidents have been reduced in the past 25 years—some of these were ordinarily termed man-failures. Naturally we have not nor will we ever entirely eliminate accidents in railroad service, but we are happy in our accomplishments. We are ready to have anyone examine our records and we are ready to have anybody question our reports, because they are of a necessity based on facts as nearly as the facts can be discerned at the time of the investigation.

Our purpose in investigating accidents is not mere curiosity, but is for the purpose of preventing reoccurrences of similar mishaps. The matter of boiler explosions, which I shall show you, have been reduced 90 per-cent during the 25 years this law has been in force. We go into these accidents very, very thoroughly.

In investigating what we term "crown sheet" accidents, there are infallible indications that point out to us if the particular accident was due to low water. I want to prove to you that we do carefully investigate all such accidents. We never go to an accident with our mind made up. We investigated such accidents in the early years of the law and one or two not so very long ago, that were not due primarily to low water, but due to bad water. Let me tell you the difference briefly.

In a legitimate case of low water, the crown sheet is overheated uniformly. The extent of overheating depends on the height of the water, or in other words how low the water has become and the part of the firebox sheets that are uncovered and exposed to the terrific heat from the fire. The more intense the heat and the lower the water, the bluer the color. In many such cases, there is a gray line, or what we call the low water line, plainly visible.

We have investigated accidents caused by improper conditions, that possibly 25 years ago would have been called low water cases—man-failures. There was no one to contradict, because there was no Federal investigation. I do not mean to imply that mechanical officials were dishonest, but I do say they had to do some things before the Boiler Inspection Law, that they did not want to do; in other words, they frequently went to the scene of the accident with their minds made up.

There is a decided difference in the indications of a boiler explosion when such explosions are due to low water than, for instance, an accident due to mud or scale adhering to the crown and other firebox sheets, in the latter cases the crown sheet will only show overheating at such places where the mud or scale had been, and almost invariably the overheating will be in areas, perhaps 24 inches in diameter or larger or smaller spots as the case may be. In cases of low water, the highest portion of the crown sheet will usually show uniform overheating.

If there are defective crown stays or firebox sheets that cause or contribute to the accident, we can find the evidence of such defective conditions, and they are plainly covered in our accident reports. There is a difference between an actual low water case and a case of overheating, due to scale or mud.

We have had cases, where the boiler explosion was due to bad water. In that case, almost invariably you will find the side sheets of the firebox a deeper blue than the crown sheet itself, and, as you know, the crown sheet is the highest part of the firebox.

I want you to know that our purpose in investigating accidents is not to "hang" it onto anybody. We do not put anybody in jail. We do not penalize the individual, nor do we penalize the railroads, unless we find the water glass stopped up, injectors inoperative or other defective conditions. We have had some cases of this kind, where the tubular type of water glass was carelessly applied—sometimes the glass was too short and the rubber gasket, due to heat will shrivel and close one end or another of the water glass which will result in a false indication of water. I remember we investigated an unmistakably low water case some years ago, the water glass was standing half full of water, when we made our investigation, because the bottom of the water glass was plugged solid with a rubber gasket.

It took the railroad employes, principally the engine service employes, years to get Congress in the frame of mind and to convince them, that some law governing the inspection of locomotive boilers was necessary. This agitation started back in 1908.

The first enactment was the Ash Pan Law. Our locomotives at that time were equipped with flat bottom ash pans, a door or damper at the front and rear. To clean those ash pans was not a particularly hard job, if there was a fairly good ash pit, but thousands of ash pans were dumped out on the road, where the fire boy had to get out and get under.

As I will try to show in the following paragraphs, while there was considerable antagonism and lack of co-operation in the earlier days, that antagonism has largely been replaced by confidence. We now have the generous and whole-hearted co-operation of the railroads as a whole. They are working with us in an endeavor to maintain locomotives in such condition so as to prevent accidents. I believe I am also safe in saying that we now have the sincere support and co-operation of practically every mechanical official in the United States.

The Ash Pan Act

It had been the practice of many of the railroads to equip their locomotives with ash pans that could be cleaned only from underneath the locomotive. The cleaning operation presented many hazards, including

*Abstract of address presented before the Central Railway Club, Buffalo, N. Y., September 10.

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the difficulty and danger of entering between the wheels to get under the locomotive and return therefrom, and the restricted working space while under the locomotive and between the rails. The prone position it was necessary for the employe to assume while cleaning the ash pan by means of a hoe, often in snow, ice, or water that may have been on the track, precluded the possibility of the employe doing anything to save himself from injury or death if any movement of the locomotive occurred while thus engaged.

Many employes had been permanently injured and many others killed while cleaning ash pans. It was apparent that this exposure to danger was unnecessary and after a number of years of intensive effort on the part of the employes they were successful in having a bill introduced in the Senate and in the House to require the railroads to equip their locomotives with ash pans that could be cleaned without the necessity of any employe going under the locomotive.

Hearings were held by the House Committee on Interstate and Foreign Commerce on May 8, 9 and 22, 1908, and by a Subcommittee of the Senate Committee on Interstate Commerce on May 9 and 22, 1908, during which testimony was introduced to show that in the prior year 14 persons were killed and 119 injured while under locomotives cleaning ash pans, and that the rate of casualties in earlier years was similar. Further testimony was given which showed that a large proportion of these injured were permanently incapacitated from doing any work and that practically all the remainder were incapacitated to such extent that they would never be able to perform their accustomed duties. Testimony was introduced by representatives of some of the railroads to the effect that the use of ash pans that could be cleaned without the necessity of going under the locomotive was not practicable, but this contention was refuted by others who presented statements from employes of railroads using such ash pans showing that many of these ash pans were in daily use, were entirely practicable, and that their use had eliminated deaths and injuries caused by going underneath the locomotives to clean the ash pans.

The bill was reported upon favorably by both Committees, passed by Congress, and approved by the President on May 30, 1908.

The act makes it unlawful to use any locomotive in moving interstate or foreign commerce that is not equipped with an ash pan which can be dumped or emptied and cleaned without the necessity of any employe going under the locomotive. Exemption is made for locomotives upon which, by reason of the use of oil, electricity, or other such agency, an ash pan is not necessary. A penalty is provided for any violation thereof, and provision is made for enforcement through the Interstate Commerce Commission. The Act was made effective January 1, 1910, thus allowing the railroads ample time in which to make the necessary changes.

Application of the ash pans required by the Act stopped the occurrence of casualties to those whose duty it was to clean the pans as it was no longer necessary to go underneath the locomotives for this purpose.

Authentic records show that 14 persons were killed and 119 injured in the year 1907 while under locomotives cleaning ash pans, and that the rate for earlier years was similar. It is apparent that casualties would have continued at approximately the same rate if the railroads had not been compelled to equip their locomotives in the manner provided. The direct saving in life and injuries since the effective date of the Act would therefore be represented by the casualty rate in 1907 multiplied by the elapsed time. Up to the close of the fiscal year ended June 30, 1936, the saving would be 371 lives and 3154 injuries.

The Locomotive Inspection Act

Because of frequent explosions and other accidents due to the use of defective locomotive boilers and appurtenances resulting in loss of life and injuries to employes and others, there arose a general recognition on the part of railroad employes, especially those in engine service, that reasonable safety could be obtained only through the medium of a Federal law that would require the railroads to maintain their boilers and appurtenances thereto in safe and serviceable condition. The recognized desirability of bringing about safer conditions resulted in a concerted movement to call the attention of governmental authorities to the needless waste of human resources brought about by preventable failures of boilers and appurtenances, and with the object in view of showing, by convincing evidence, that the enactment and enforcement of a Federal statute on the subject would be in the public interest.

As an outcome of a conference held on February 10 and 11, 1909, a boiler inspection bill was introduced in the Senate on March 22, 1909, and a bill having the same purpose was introduced in the House on May 17, 1909. Two additional bills were introduced in the House, one on May 20, 1909, and one on June 21, 1909.

Commencing early in 1910, hearings were held before the House Committee on Interstate and Foreign Commerce on the House bills, and before the Senate Committee on the Senate bill. As a result of these hearings various additional bills were introduced in the House and in the Senate, and on June 21, 1910, the Senate Committee on Interstate Commerce reported a substitute amendment for the original Senate bill.

No final action was taken by either branch of Congress upon these bills at this session though the hearings and discussions of the committees concerning the formulation of details of an adequate bill were continued. It had now become apparent that some bill would be passed despite opposition on the part of the railroads and following adjournment of Congress various members of the House Committee, representatives of the employes, and representatives of the railroads, made a study of all the propositions involved. As a result of all this consideration and discussion various changes were agreed upon and recommended by the respective representatives of the employes and the railroads.

Following the re-assembling of Congress in December, 1910, the Senate bill which had been reported on June 21, 1910, with a substitute, was recommitted to the Senate Committee on Interstate Commerce and that Committee reported the bill back to the Senate on December 16, 1910, with a new substitute incorporating the agreed upon changes. These changes were agreed to by amendment in the Senate and the bill passed that body on January 10, 1911. The bill was then passed by the House, and was signed by the President on February 17, 1911, after the subject had been given consideration by Committees of the Senate and House for a period of two years.

The act, which became effective July 1, 1911, established a general safety standard for locomotive boilers and boiler appurtenances and provided for the appointment of a chief inspector, two assistant chief inspectors, and fifty district inspectors, whose duties were defined, and for the furnishing by the Interstate Commerce Commission of the necessary office help. Provision was made for formulation and promulgation of rules and regulations and for modifications as the need became apparent, and for enforcement procedure.

Amendments Increase the Scope of the Work

After the effective date of the Act and because of the necessity of maintaining their boilers in better condition than theretofore the railroads concentrated their efforts on conditioning their boilers and appurtenances thereof with resultant neglect of other parts of the locomotives. Accidents caused by failures of parts of the locomotive other than the boiler and its appurtenances began to increase with resultant loss of life and injury to employes and travelers. The employes again appealed to Congress for relief in the form of an amendment to the Boiler Inspection Act which would extend its jurisdiction over the entire steam locomotive and tender and all its parts with the same force and effect that had theretofore applied to locomotive boilers and their appurtenances.

Similar to their procedure in the earlier hearings on the Boiler Inspection Act the railroads vigorously opposed enactment of the proposed amendment; however, it was shown at the hearings held in connection with the proposed amendment that the Boiler Inspection Act had worked out to the satisfaction of all, including the railroads, and that there was need in the public interest for extension of jurisdiction over all other parts of the steam locomotive. A bill incorporating the proposed amendment was passed by Congress and signed by the President on March 4, 1915.

Due to the growing use of locomotives propelled by power other than steam, and industrial conditions that developed in the years 1922 and 1923 which resulted in the railroads failing to maintain their locomotives in such condition as to avoid unnecessary accidents, it became apparent that the provisions of the act should be extended to include all locomotives irrespective of the kind of power used for propulsion, and that an increased force of Federal inspectors would be necessary if the standards of safety heretofore attained were to be continued. The railroad employes brought these circumstances to the attention of Congress and a further amendment making the provisions of the law applicable to any locomotive, steam or others, used or permitted to be used on the line of any carrier and authorizing the Interstate Commerce Commission to appoint not more than fifteen additional inspectors was passed without opposition and signed by the President on June 7, 1924.

Condition of Locomotives Encountered in Enforcement

The necessity for the law was brought about by the general practice on the part of the railroads of subordinating the making of needed repairs to the requirements of convenience. Practically all the large railroads had inspection and repair rules that were more or less adequate but these rules were generally considered as being merely expressions of desirable practices and little if any attempt was made to apply substantial repairs if any inconvenience would be caused thereby. As a consequence of this policy ineffectual or temporary repairs were often applied, or the locomotives were continued in use without making any repairs, and with known existing defects, until failures, often resulting in deaths or injuries, occurred.

Table 1 shows some of the particularly hazardous conditions that were frequently found by our inspectors:

Defects such as enumerated in Table 1 are now rarely found. Bearing in mind that it is the purpose of the law to promote safety it is the constant endeavor to prevent violations by following the practice of reporting and having prompt repairs made of all defects before they become serious as it is apparent that the purpose of the law can be served best by this procedure rather than waiting until violations occur and then filing suits to enforce the penalty provided. The officials on practically all railroads have generally co-operated in the carrying out of the provisions of the law.

The practical elimination of the conditions formerly existing has not only resulted in more economical and vastly safer operation but has been the means of making practicable long locomotive runs and faster train speeds with a reduction in the quantity of fuel consumed per unit of work performed.

Table 2 shows the percentage of locomotives inspected found defective by our inspectors in the fiscal year ended June 30, 1912 (the first year in which the Boiler Inspection Act was effective) and the number of locomotives ordered withheld from service by our inspectors because of immediately unsafe conditions, and similar data for the fiscal year ended June 30, 1936. The two periods are not directly comparable because the statistics for the year ended June 30, 1912, include only defects of the boiler and its appurtenances while those for the year ended June 30, 1936, include all parts of the locomotive, and tender; however, the table does show the relative improvement made in the interim.

Table 2—Percentage of Locomotives Found Defective

	Fiscal year ended June 30	Percentage of locomotives inspected found defective	Number of locomotives withheld from service because of immediately unsafe condition
Boiler and its appurtenances only........	1912	65.7	3,377
All parts of the locomotive, including the boiler and its appurtenances, and tender..	1936	12	852

There are no authentic records of the total number of casualties caused by defective locomotive boilers and their

Table 1—Locomotive Defects Which Caused Serious Accidents

Cracks and grooves in boiler shells, roof sheets, and back heads.

Cracks in firebox sheets.

Bagged crown sheets.

Bagged or blistered arch tubes.

Broken braces, crown stays, and stay bolts.

Leaks from defective boiler joints, loose stay bolts, studs, and rivets.

Flues plugged because of cracks or pit holes or otherwise defective; plugs held in place by friction only and liable to blow out at any time.

Safety valves not of sufficient relieving capacity or set at higher pressures than should have been carried by the boiler.

Inaccurate steam gages.

Defective pipes carrying boiler pressure in cabs.

Leaking boiler checks.

Injectors inoperative or unreliable.

Defective and inaccurate water level indicating devices.

Steam leaks around front ends of locomotives obscuring the view of track and signals.

Steam leaks in cab from valve packing, pipe joints, gage cocks, staybolts, studs, and washout plugs, often to such extent that the occupants could not see each other across the cab in severe winter weather.

Glass in front cab windows broken out and windows boarded up.

Leaking throttles and means not provided to hold throttles in closed position.

Air compressors running hot and not supplying sufficient volume and pressure of air to properly charge the brake system.

Leaks in driving brake and tender brake cylinders and connections rendering the brakes inoperative.

Corroded and weakened main air reservoirs that were liable to explode at any time.

Cut and scored axles and crank pins causing bearings to run hot continually.

Cracked and bent side and main rods and excessive lost motion in bearings.

Cracked and broken crossheads and scored piston rods.

Draw gear between locomotive and tender not maintained in safe condition and draw gear not of sufficient strength.

Broken driving boxes and loose pedestal binders.

Loose tires and wheels otherwise defective.

Improperly maintained valve gear and reverse gear.

Broken driving and truck springs.

Top of feed-water tanks behind coal space filled with coal and cinders or other foreign matter rendering it hazardous for a person to mount the tank to take water. Corroded sheets in the tops of feed-water tanks letting coal and cinders into the water causing inerference with operation of injectors and boiler checks.

Inefficient headlights in which it was common practice to use a hand lantern to illuminate the track ahead.

appurtenances prior to the enactment of the Boiler Inspection Law, but in the first year of the operation thereof 91 persons were killed and 1005 injured as a result of the failure of some part or appurtenance of the locomotive boiler. Activity on the part of the railroads in improving the condition of their boilers was started as soon as it became evident that a law covering the subject would be enacted and it is therefore apparent that the boilers were improved and that the number of casualties was considerably less in the first year that the Act was operative than in the prior period.

Table 3 shows a comparison of the number of persons killed and the number injured as a result of failure of boilers and their appurtenances for the first fiscal year in which the Act was operative and for the year ended June 30, 1936.

TABLE 3—NUMBER OF PERSONS KILLED OR INJURED AS RESULT OF BOILER FAILURES

Boiler and Its Appurtenances Only	Year Ended June 30 1936	1912
Number of persons killed	10	91
Number of persons injured	79	1005

The total number of persons killed as a result of failures of boilers and appurtenances in the period shown was 717 and the total number injured was 8770. If the casualties had occurred at the same rate throughout the period as they occurred in the first year in which the Act was effective there would have been 2275 persons killed and 25,125 injured. The direct saving in the number of persons killed would therefore be 1558, and the direct saving in the number injured would be 16,355.

The net sum of the direct savings in life and injuries since the effective dates of the Boiler Inspection Act and the amendments is 1622 deaths and 14,700 injuries, or a reduction of 64.7 percent in the number of deaths and a reduction of 48.9 percent in the number of injuries that would have occurred if casualties had continued at the same rates as in the first years the Act and the amendments became effective.

CROWN SHEET OR LOW WATER ACCIDENTS

During the hearings in 1909 and 1910 much was said by mechanical officials that practically all boiler explosions resulted from low water and therefore were man-failures and therefore no law or rules would ever prevent such accidents. What does the record show in this respect?

In 1912, the first year of the law, a total of 94 crown sheet accidents occurred resulting in the death of 54 persons and the serious injury to 168 others. Now comparing that record with the past fiscal year we see that there were but 9 such accidents, 8 killed and 10 injured, or a reduction of about 90 percent in crown sheet accidents, 85 percent in the number killed and 94 percent in the number injured. Surely the above shows that Federal supervision plus better and more reliable water gaging devices, better injectors and cleaner and properly maintained boilers have reduced so-called man-failures almost to the point of disappearance.

Table 4 showing a comparison of locomotive boiler accidents during the years of 1911-1912 and the year ending June 30, 1936, will be of interest. It shows a total of 856 accidents resulting from failure of locomotive boilers and their appurtenances occurring the first year compared with 74 last year, a reduction of 91 percent; 91 killed as compared with 10 last year, and 1005 injured as compared with 79 in 1935-1936; 89 percent reduction in the number killed and 92 percent in the number injured.

The machinery accidents since 1917 have been decreased 40 percent, number of persons killed 30 percent,

TABLE 4—COMPARATIVE STATEMENT OF BOILER ACCIDENTS FISCAL YEAR ENDING JUNE 30, 1936, WITH YEAR ENDED JUNE 30, 1912

Nature of Accident	1912 Accidents	1912 Killed	1912 Injured	*1936 Accidents	*1936 Killed	*1936 Injured
Shell explosions	3	27	41	..	..	..
Crown sheet; low water; no con. causes	69	35	129	6	8	5
Crown sheet; low water; con. causes	23	15	38	2	..	3
Miscellaneous firebox failures	2	4	1	1	..	2
Total crown sheet and firebox failures	94	54	168	9	8	10
Percent decrease from 1912	..	..	..	90	85	94
Total (all boiler and its appurtenances)	856	91	1005	74	10	79
Percent decrease from 1912	..	..	..	91	89	92

*Figures for 1936 subject to slight change

and the number injured 49 percent, but time will not permit further detail.

The inspectors of the Bureau of Locomotive Inspection, since the effective date of the law, have inspected a total of 1,977,122 locomotives of all kinds, 677,231, or 34 percent of which were reported defective and 67,075 were in such condition they were ordered out of service on Form 5.

We have investigated 13,513 accidents resulting from failure of the boiler, the machinery or appurtenances thereof which resulted in 884 persons killed and the serious injury to 15,356 others, and as I have endeavored to show by deduction earlier in this paper that if it had not been for the locomotive inspection law the casualties would have been considerably larger.

Model Plant for Steel Research Work

A miniature steel works for developing the discoveries of its research engineers is being constructed by the Jones & Laughlin Steel Corporation, it was announced recently. One of the first of its kind in the country, the midget plant will be equipped with actual steel-making units on a small scale capable of duplicating the operations in the big mills necessary to manufacture of iron and steel.

The construction of this miniature steel works marks a new approach to the use of research by industry, bringing it into a position of greater and more practical importance than ever before. In the past it has been the general practice to turn over the discoveries of research engineers to the regular manufacturing departments for testing and development. Under this new system Jones & Laughlin engineers will develop and test their ideas in the new "pilot plant" where they will have entire control of the miniature steel-making equipment which will include an iron cupola, an open-hearth furnace, a Bessemer converter, a blooming mill, and various finishing devices.

In addition to housing the "pilot plant," the present research staff and equipment will be transferred to the new building which will be constructed along Longworth Street in the Hazelwood district of Pittsburgh. With the transfer of present research equipment and the purchase of additional machines, the research department in the new building will include practically all the facilities known to science for testing and examining steel. An enlarged staff of trained scientists and technicians will conduct the experiments. The new project is expected to be in operation by the end of the year.

Marine Inspection Bureau Issues

Qualification Tests for Welders

The following information has been transmitted to boiler manufacturers, shipbuilders and contractors by the Bureau of Marine Inspection and Navigation on the subject of qualification tests for welders:

On June 1, 1935, the bureau issued a circular letter outlining welding procedure, including specifications for qualification tests of welding operators, in compliance with which qualification tests have been made of approximately 875 welding operators. The results of these tests have been very interesting and educational to the bureau and to the industry itself.

From the knowledge gained in making these tests, together with the comments and suggestions received, and in view of the rapid strides made in the art of fusion welding during the past year, it is now considered advisable to revise the procedure and instructions contained in the above-mentioned circular letter, and to make special provision for the annual requalification tests of welding operators, in addition to the primary tests which still have to be made of many welding operators.

The requirements for requalification tests apply only to those welding operators who have successfully passed the prescribed primary tests. Welding operators who have not yet passed the primary tests will be subjected to the requirements for primary tests hereinafter specified. Therefore, it follows, that the letter of June 1, 1935, is null and void, and the new requirements and instructions specified are to repeal the former.

As stated in Bureau Circular Letter No. 76, dated April 20, 1936, welding operators who have not submitted specimens for primary tests or who have failed to pass the prescribed tests will not be permitted to do welding work on boilers, pressure vessels or other special work for which qualified operators may be required.

Welding operators who have failed to qualify in accordance with the provisions of the circular letter of June 1, 1935, cannot be permitted to do welding work on boilers or pressure vessels subject to the jurisdiction of this bureau unless and until they have submitted test specimens that have successfully passed the prescribed tests. These tests are to be made with welding equipment and material representative of that which is actually used in their work.

Primary Tests of Welding Operators

Individual welding operators who have not as yet passed their qualification tests are required to furnish specimens of their work for tests by this bureau. The specimens are required to be prepared in the presence of a duly authorized inspector, stamped with his initials and the initials of the operator preparing the specimens, and forwarded to the National Bureau of Standards, Division 6, Section 5, Washington, D. C.

Where specimens are machined, the side on which the top of the weld is located shall be marked "F" to indicate the face of the weld, said marking to be placed only on one end.

Inspectors who witness the preparation of the test specimens are required to report the preparation of these specimens on official Form 964 (formerly 76), copies of which will be furnished to local inspectors, and forward same to the bureau as soon as possible.

The mill test report of the plate used in the preparation of the specimens, or preferably the inspector's report, if tested marine steel is used, shall be forwarded to the bureau with Form 964 (formerly 76). If inspector's report or mill test report is not available, a specimen of the solid plate (without welds) from which the specimens are prepared shall be submitted in order to determine the physical properties of the base metal.

The minimum thickness of the material used shall be ⅝ inch, and the maximum 1 inch. The specimens may be submitted either in the stress relieved or in the unstress relieved condition.

Test Specimens—The tension test specimens shall be machined to the form and dimensions shown in Fig. 1 of drawing No. 5, approximately 18 inches in length, with a reduced section not less than 9 inches in the center, the width to be one and one-half times the thickness of the material. This coupon shall be cut in two in the center and butt-welded, and the reinforcement machined off flush with the plate, in order that the actual strength of the weld may be fairly evaluated with the parent metal. These specimens shall show a tensile strength equal to the minimum of the range of the plate from which the test specimen was prepared.

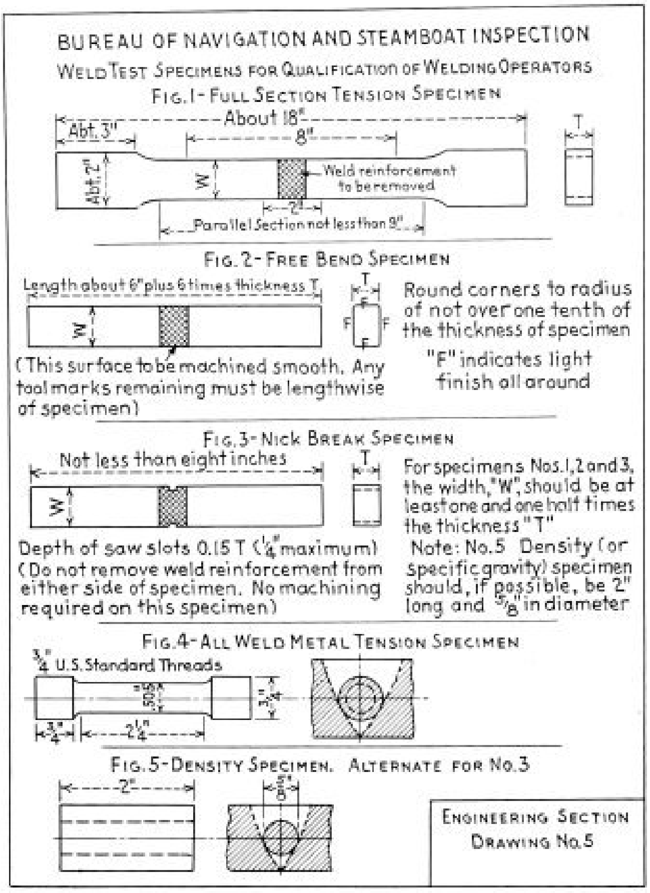
One tension test specimen of all-weld material representative of the longitudinal weld shall be made. This may be prepared according to the standard dimensions for the butt-welded specimens described in the preceding paragraph, or may be made to the dimensions of a standard tension test specimen, having a gage length of 2 inches on the reduced section, and a diameter of 0.505 inch, as shown in Fig. 4 of drawing No. 5. This specimen is used to determine the tensile strength and elongation of the deposited metal of the welding rod used and shall show a tensile strength at least equal to the minimum of the range of the plate which is used, and an elongation of at least 20 percent in 2 inches.

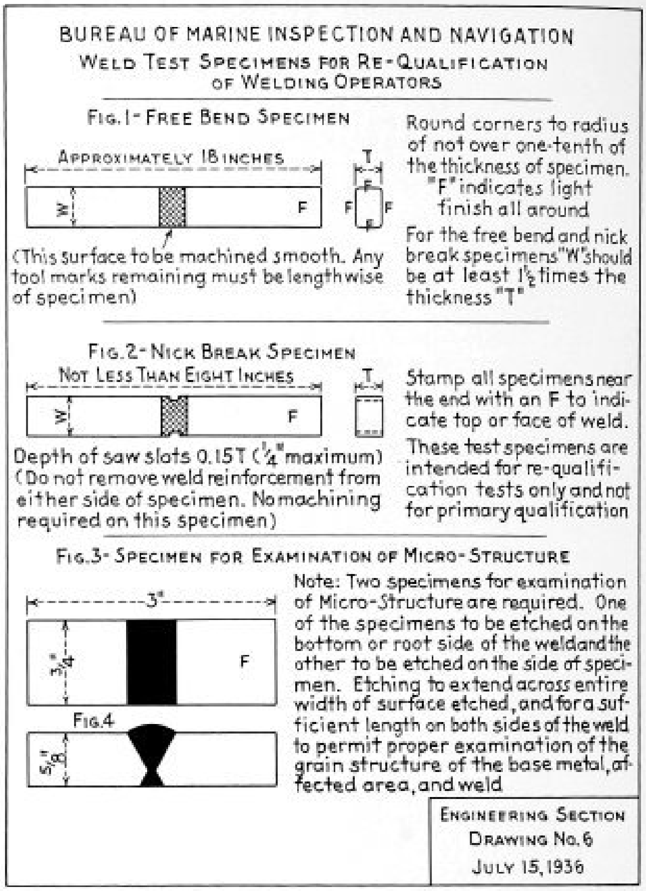
One nick-break test specimen as shown in Fig. 3, of Drawing No. 5, having a length approximately 18 inches, shall be cut in two in the center, and butt-welded, the edges of the weld being nicked on either side to permit a clean break, the width of the weld to be approximately one and one-half times the thickness.

The nick-break specimen shall show complete penetration and absence of slag or oxide inclusion, and a degree of porosity not to exceed six gas pockets per square inch of the total area of weld surface exposed on the fracture. Density specimens may be substituted for the nick-break test specimens if desired.

Where density specimens are substituted for the nick-break specimens, they shall be made in circular form, with a diameter of ⅝ inch, and a length of 2 inches, cut out of the weld as shown in Fig. 5 of Drawing No. 5. Such specimens shall show a specific gravity not less than 7.80.

One bend-test specimen shall be machined to the form and dimensions shown in Fig. 2, of Drawing No. 5, the length of which shall be approximately 18 inches,





and have a width equal to one and one-half times the thickness. The edges may be rounded to a radius of 0.1 *T*., this specimen to be used for evaluating the ductility of the weld by the free-bend method. It should show a minimum elongation of 30 percent across the fibers of the weld.

Requalification Tests of Welding Operators

Welding operators who have qualified and passed their primary tests are required to be requalified at the end of one year from the date of their approval. Test specimens for requalification are as follows:

One free-bend test specimen, made to the form and dimensions shown in Fig. 1 of Drawing No. 6.

One nick-break test specimen, prepared in accordance with Fig 2 of Drawing No. 6.

The requalification test specimens shall be prepared in the presence of a duly authorized inspector in the district where the operator is employed, preferably at the plant of the manufacturer, the requirements for the tests being as follows:

The free-bend test specimen shall show an elongation of 30 percent across the fibers of the weld.

The nick-break test specimen shall show complete penetration, absence of slag or oxide inclusions, and a degree of porosity not to exceed six gas pockets per square inch of the total area of the weld surface exposed in the fracture.

Density specimens may be substituted for the nick-break specimens, if desired, and if used, shall show a specific gravity of not less than 7.80.

Where density specimens are substituted for the nick-break specimens, they shall be made in circular form, having a diameter of 5/8 inch, and a length of 2 inches. The material shall be cut out of the weld as specified by the Bureau.

The above specimens shall be of material having a minimum thickness of 5/8 inch, and a maximum thickness of 1 inch, and may be submitted either in the stress relieved or unstress relieved condition. The side on which the face of the weld is located should be stamped with the letter "F" near the end.

The inspector witnessing the tests of the specimens shall report the results of the tests to the Bureau on approved form, 964-A, copies of which will be furnished the local inspectors, and forwarded to the Bureau with the certificate of the operator. In the event that the requalification tests are satisfactory, the sheet covering that requalification test will be executed and returned to the operator.

*Etch test specimens.** In addition to the above, it is required that each operator prepare two specimens for examination of the micro structure of the weld made to the form and dimensions shown in Figs. 3 and 4 of Drawing No. 6. These specimens shall be etched as follows:

No. 3 on the bottom or root side of the weld.

No. 4 on the edge of the weld.

These specimens shall be of a length sufficient to permit of proper examination of the grain structure of the base metal, affected area, and weld. These etched specimens are to be forwarded to the Bureau by the inspector for test.

The etch specimens may be taken from the ordinary test plates which are welded during the fabrication of the boiler or pressure vessel.

All specimens tested by the local inspectors shall be retained by them for sixty days.

*For micro etching, the specimens shall be treated with a four percent nital solution. After etching, the etched surface shall be treated with a compound or solution which will prevent obliteration of the etching.

Operators' certificates.—Certificates are now being issued to welding operators who have successfully passed the prescribed tests. Three copies will be prepared for each welding operator, one copy to be retained in the Bureau's files, one copy for the local inspectors in the district where the operator is employed, and one copy for the operator, to be delivered to the employer and kept in his files as long as the operator is employed by him; it shall be available to inspectors at all times. It will be necessary that each operator furnish three small photographs of himself to be attached to the certificate. It is the duty of the inspector to see that these photographs are pasted in the proper place on the last sheet of the certificate; he shall also witness the impression of the thumb-print of the operator's right hand in the place provided therefor, and shall obtain his signature. These acts shall in all cases be witnessed by the inspector, after which the copy marked "Bureau copy" shall be returned to the Bureau.

When an employee leaves his position, the manufacturer is requested to fill in the blank service record on the last sheet, certifying the date upon which the employee left his employ, and the reason therefor.

Welding operators who have qualified in the electric metallic arc process will be classified as A, B and C welding operators as follows:

Operators who have qualified in the overhead position, by hand or machine, will be classed as A welding operators, and given an identifying number, the entire symbol reading "A-1," "A-2," etc. Such welding operators will be permitted to do welding in any position by the process and method for which they have qualified.

Welding operators who have failed to qualify in the overhead position, but have passed their tests in the vertical position, will be permitted to do welding in the vertical, horizontal, or flat positions, and will be designated as B welding operators, the symbol being "B-1," "B-2," etc.

Welding operators who have failed to qualify in the overhead and vertical positions, but who have successfully passed their tests in the horizontal or flat positions, will be classed as C welding operators, the symbol being "C-1," "C-2," etc.

Welding operators who have qualified by the gas process will be classified as D, E, and F welding operators as follows:

Operators who have qualified in the overhead position, by hand or machine, will be classed as D welding operators, and given an identifying number, the entire symbol reading "D-1," "D-2," etc. Such welding operators will be permitted to do welding in any position by the process and method for which they have qualified.

Welding operators who have failed to qualify in the overhead position, but have passed their tests in the vertical position, will be permitted to do welding in the vertical, horizontal, or flat positions, and will be designated as E welding operators, the symbol being "E-1," "E-2," etc.

Welding operators who have failed to qualify in the overhead and vertical positions, but who have successfully passed their tests in the horizontal or flat positions, will be classed as F welding operators, the symbol being "F-1," "F-2," etc.

Approval of welding rods.—The results of tests made of welding operators during the past year have demonstrated the absolute necessity of establishing an approved list of welding rods for use in the manufacture of boilers and pressure vessels. Below is given a list of the rods selected, based upon tests made, as a nucleus for establishing such a list.

Manufacturers desiring approval of other welding rods may have their material approved by submitting specimens of deposited metal made from their rods in the presence of an inspector, the specimens to be tested at the National Bureau of Standards, and should also submit such scientific data and facts as they may be able to produce showing that dependable sound welds can be made with their products.

The list of rods at present approved is as follows:

Lincoln Fleetweld No. 5, manufactured by the Lincoln Electric Company, Cleveland.

General Electric No. W-20 and W-23, manufactured by General Electric Company, Schenectady, New York.

Wilson rods, manufactured by Wilson Welder and Metals Company, Inc., 2 Rector Street, New York, New York.

Una rod, Una Weld Manufacturing Company, of Texas.

Airco Co. 78, Air Reduction Company, 60 East 42nd Street, New York, New York.

Babcock and Wilcox Company, 85 Liberty Street, New York, New York.

Hedges - Walsh - Weidner Company, Chattanooga, Tennessee.

Red Devil, manufactured by the Champion Rivet Company, Cleveland.

Murex Welding Rod, Metal and Thermit Corporation, 120 Broadway, New York, New York.

All of these rods used for electric metallic arc welding shall be of the shielded type.

For oxy-acetylene welding the Oxweld welding rods, manufactured by Union Carbide and Carbon Company, 30 East 42nd Street, New York, New York, will be accepted.

Shop inspection.—Inspectors detailed to shop inspection are required to exercise extreme vigilance to assure themselves that the rolled plates are properly prepared and formed, so that the edges come fair without necessitating force or pressure to draw them together. Moreover, they should be careful to ascertain that the material conforms to all the requirements, and in cases where plates are tested by an inspector, a record shall be kept of the plate and butt-strap serial numbers entering into the construction of each vessel. Cylindrical shells shall not deviate more than one percent from a true circle, and, if necessary, the plates shall be rerolled or reformed in order to bring them within this tolerance.

Radiographs.—Radiographs made in accordance with the requirements of Section W-20-5 shall be forwarded to the Bureau for examination and retained by the Bureau as a part of the permanent record of the boiler.

Inspectors are required to witness the placing of the films and the taking of the radiographs, in order that they may be assured that the procedure complies with all the requirements of W-20-5, and that the plates are properly marked so that the image of the marking will be taken on the films. Time, care, and diligence must be used in making the shop tests of the test plates taken from the structure for two reasons, namely, to assure good construction, and as a check on the ability of the welding operator to produce sound welds. In the event that the test plates show inferior workmanship, the welding operator shall be subjected to a requalification test.

The films used shall be of the acetate cellulose type (non-inflammable). Nitro cellulose films (inflammable) will not be accepted.

The length of the films shall not exceed 17 inches, and the width 5 inches.

Inspectors.—Inspectors shall be assigned by the local board of the district where the boiler manufacturer's plant is located, to remain on duty in the plant and supervise the construction of boilers by any process of fusion welding. When boilers are being constructed for use on vessels subject to the jurisdiction of this Bureau, it shall be the duty of the inspector to satisfy himself that the work is being done in strict accordance with all of the requirements of the rules; but, where the plant is operated on a day and night basis, it will not be necessary to have an inspector stationed at the plant day and night. The inspector on the day shift shall check up on the welding operators employed on other shifts, examine the fit-up of the work, etc. This can be arranged so that the welding may be carried on continuously.

The new orders for qualifying welders were signed by Joseph B. Weaver, director of the Bureau of Marine Inspection and Navigation.

The Foreman Becomes An Executive*

By C. M. White†

Today the foreman, instead of being a driver of his men, has become an executive. In our organization, for instance, a foreman has an average of 25 men working under him. This compares with an average of 42 men employed in the average industrial plant. That means that our foremen have nearly as many men to direct in their work as has the head of the average manufacturing plant. The foreman of today consequently must be responsible, capable men. To my mind the ideal foreman must have such qualities in his character as these:

A foreman must know, in minute detail, the mechanics and processes of all work for which he is responsible. He should have a mind flexible enough both to understand and to appreciate the advantages of processes used by competitors or rivals even though the adoption of them may put out of commission some pet scheme of his own. When a man once acquires a real sense of appreciation for what other individuals in his own particular field have done, he has made his first long stride into that select class of people who are generally termed "big." I do not mean big in stature, or having a big office or a big home. I mean "big" mentally—with a real willingness to try out some new ideas without a fight.

A foreman must be a leader of men. By that I mean he must lead, not drive, them in their work. He should be the type of man to whom his subordinates look instinctively for direction, for leadership, and for help in any problem which may confront them.

A foreman must be a diplomat. He must be tactful. Men do not respond and give their best efforts when simply receiving curt orders. They like to know why they must do things in a different way from that to which they have been accustomed. They like to know the reasons for changed plans or new methods. If they understand what you want, they will take a much keener interest in their jobs, will do a better day's work, and will be happier than if they are just mechanically doing their part in a series of operations.

A foreman must not only know his job but the job of every man working for him. Unless this is the case, he can neither command the respect of his men, nor will the work for which he is responsible be properly done.

The ideal foreman should know something about the broader problems of the company for which he is working. By that I do not mean that he should have the company's financial, sales or distribution problems at his fingers' tips, but he should be able to answer intelligently some of the questions which may arise about these fundamental matters.

A foreman should be sympathetic. He should not be above listening to and giving advice about the problems that confront the men in his charge. All of us have such problems about which we ask the advice of men whom we think know more than we do.

A foreman should be ambitious. He should look forward to the day when he is going to hold a better job, make more money. That means that he has to study the job of the man above him and at the same time train a man to take his place, so that when the opportunity comes, he is ready for promotion.

One of the most important duties that the foreman has is handling his boss. Study him, find out how he likes his reports to come in, and learn when is the most suitable time to talk to him about your problems. Many a good idea is lost in the shuffle because some one tries to crowd it in on a man who has so many other things on his mind that he cannot give it proper consideration. Remember that a superintendent or manager has to absorb, consider, and weigh a tremendous amount of detailed information at all times. Their decisions are not personal whims nor do they get the answers to questions out of a book. Their decisions are based on judgment, experience, and a great amount of facts and figures either carried in their minds or at hand. A difficult decision demands consideration not only of the immediate problem but also of whether the decision at the moment will start the company on a policy of doing things which may radically affect the future course of the company. When a man is stewing over two or three of these problems at one time, you certainly can not expect very much consideration for the particular scheme which you have just worked out for your own particular department. When you want to try a new process or secure a new piece of equipment, get the facts all together—explain just why it is needed, what will be gained by it, and give some idea of what it will cost. Do not see how long a letter you can write on

* Abstract of an address before the thirteenth annual convention of the National Association of Foremen, Youngstown, O., September 19.

† Vice-President in charge of operations, Republic Steel Corporation, Cleveland.

the proposition. See how short you can make it. The more briefly, the more concisely, and more clearly you can present any request, the more likely you are to get action on it. Long letters and long reports are frequently laid aside by your executives until they find time to read them or they are turned over to a subordinate to find out what they are all about.

A substantial proportion of the labor troubles in industry can be traced to a lack of foremen of the type I have just described. I know of no more potent cause of strikes, dissension, and dissatisfaction on the part of industrial employes than foremen who still don't realize that their job requires more thinking, less force, more executive ability and less bullying.

Examining Candidates for Locomotive Inspector

One of our readers knowing the wide interest attached to civil service examinations for Federal inspectors for service in the Bureau of Locomotive Inspection, has compiled a series of questions similar to those presented for solution in the examinations recently held throughout the country. Probably five or six years will elapse before another examination is held by which candidates can qualify for inspectors' appointments. It is not too soon, however, for prospective candidates to become familiar with the type of questions asked and to improve their chances by studying the general subjects involved in the examination.

Procedure of Examinations

The candidates present their admission cards with personal photographs attached and seat themselves at small desks placed about four feet apart. Each furnishes his own pen, ink and eraser but the paper is supplied by the examiner. After filling out a preliminary form which contains questions concerning the applicant's education and experience and coaching received for this examination, the first batch of questions is distributed—10 arithmetic problems with a 40-minute total time limit. The only paper supplied to work these is the margin of the sheet the problems were written on. Four similar problems appear below:

1. How many bricks 4 by 8 inches in size would be required to build a walk 128 feet long and 4 feet across making no allowance for those that might lap over these dimensions?

Discussion: To work this in a hurry, it would be better to consider how many rows of bricks 4 inches wide would make a four-foot walk, and then how many rows 8 inches long would it take to reach 128 feet, than to approach the problem by finding the area of the walk and a brick in square inches and dividing it out.

2. Six men working 10 hours a day do a piece of work in 5 days. How long would it take 5 men working 8 hours a day working at the same rate?

3. Thirty percent of a man's age is equal to 40 percent of the age of his wife. The man is 60 years old, how old is the wife?

4. The top of a ladder is leaning against a wall. The wall is 40 feet high and the bottom of the ladder is 30 feet out from the wall. How long is the ladder?

A correct set of answers is good for 5 points on the examination.

Some of the other questions and assignments follow:

Describe a locomotive boiler.

Why are two safety valves used on a locomotive boiler?

What percent of phosphorus and sulphur are allowed in boiler steel?

What effect does more than this amount of sulphur have on steel?

What is grooving? What is pitting?

What is the advantage of using a feed-water heater on an engine? Describe one type.

What would be the effect if the expansion pad bearers were insecurely attached to the frame or the pads loose on the firebox?

What effect does a short circuit have on a headlight?

What is a volt? An ampere? A watt?

What is the difference between direct and alternating currents?

What is the fundamental difference between a Diesel engine and a gasoline engine?

What is the difference between a gas-electric and a gasoline locomotive?

A round flue sheet brace supports an area 10 by 12 inches. What is the stress in this brace in pounds per square inch in a boiler carrying 200 pounds steam pressure?

What is the tension on the plate of a boiler shell having plate $1\frac{1}{16}$ inches thick; rivets in the outer row of the seam $1\frac{3}{16}$ inches diameter and $8\frac{3}{4}$-inch pitch; the shell 91 inches in diameter and the steam pressure 220 pounds?

Write a report of 300 words or more covering an imaginary boiler explosion caused by something other than low water. (Three hours allowed for this.)

What is tractive force? How much force would be required to move a ton on straight level track at uniform slow speed assuming plain bearings?

What is the cause of laminations in boiler plate?

Evening Welding Course Being Given

The New York section of the American Welding Society has arranged with the Brooklyn Polytechnic Institute to present this winter a series of lectures on the fundamentals of welding. The lectures, which began on November 10, are being given in the Institute, 99 Livingston Street, Brooklyn, on Tuesday evening at 6:45.

The course comprises ten illustrated talks covering the following subjects: characteristics of the welding arc and welding flame, metallurgy and metallography of the welding of steel, physical properties of welds, welding in engineering and building construction, weld inspection and supervision, the welding of alloy steels and non-ferrous metals, the economics of welding, and the selection of welding processes. The speakers include a number of well-known welding authorities.

The first lecture was open to anyone interested in welding and the entire series are free to members of the American Welding Society. Information on the enrollment fee for non-members of the society and other particulars may be obtained from the American Welding Society, 33 West 39th Street, New York City.

Babcock & Wilcox Personnel Changes

The Babcock & Wilcox Tube Company, Beaver Falls, Pa., has recently announced the appointment of W. W. Williams, formerly general sales manager, to general manager of the company, and T. F. Thornton, formerly sales manager of the Detroit office district, to general sales manager.

Practical Plate Development—XVIII

Layout of a Transition Piece

By George M. Davies

The transition piece to be laid out is illustrated in the elevation, Fig. 149, and in the plan, Fig. 150. It consists of a transition piece "B" which has an elliptical base and which is joined with a circular connection piece "A" at right angles to the transition piece "B".

The first step to be considered in the development of the transition piece is the construction of the elliptical base as shown in the profile, Fig. 153. The center line of the transition piece *G-J* is extended down to *M*. At any point on this line as *P*, erect a perpendicular to *G-M* extending the same on each side of *G-M*. Then parallel to *G-M*, draw lines through the points *A* and *B* of the elevation, Fig. 149, cutting the line just drawn and locating the points *A'* and *B'*. *A'-B'* is the long diameter of the ellipse. Then on *G-M* on each side of *P* step off the distances *P-V'* equal to *O-V* and *P-W'* equal to *O-W* of the plan. *V'-W'* is the short diameter of the ellipse.

Then, with *P* as a center and the radius *P-V'*, describe a circle; with the same center and *P-B'* as a radius describe another circle. Divide both circles into the same number of equal parts. The easiest way to do this is to divide the larger circle into the required number of parts and beginning at the center line *G-M*, draw radial lines through the points of division on the outer circle to the center *P*. The radial lines will divide the smaller circle into the same number of parts that the larger one has been divided into.

Through the points of division on the smaller circle draw horizontal lines, and through the points of division on the larger circle draw vertical lines. The points of the intersections of these lines will be points on the ellipse. Next, draw a line through all these points of intersection completing the elliptical base as shown.

Divide the profile of the ellipse in Fig. 153 into any number of equal parts, the greater the number of equal parts taken the more accurate the final development, twenty being taken in this case, and the divisions numbered from 1 to 20 as shown.

The plan view of the base as shown in Fig. 150 is constructed in the same manner as illustrated for the profile, Fig. 153, and is divided into the same number of equal spaces and numbered corresponding to the profile, Fig. 153, from 1' to 20' as shown.

In the plan view, where the outline of the connection piece "A" overlaps the transition piece "B", the lines have been shown dotted so as not to obstruct the construction lines of the transition piece.

Next, draw lines through the points 1 to 20 of the profile, Fig. 153, parallel to the center line *G-M* extending same into the elevation cutting the base line *A-B*. Number these points from 1 to 20 as shown.

Then extending the center line *G-H* of the connection piece "A", Fig. 149, and at any point *Q* on this line, draw the profile of the connection piece "A". Divide the profile into the same number of equal spaces as was taken in the profile of the base, Fig. 153, and number the divisions from *a* to *w* as shown. Then parallel to the center line *G-Q*, draw lines through the points *a* to *w* extending same into the elevation and cutting the lines *E-F* and *C-D*. Number the intersections on the line *E-F* from *a* to *w* and on the line *C-D* from *a'* to *w'* as shown.

Connect the points *a'* to *w'* with the points 1 to 20 of the elevation, Fig. 149, with solid and dotted lines as shown. These lines represent the surface lines of the object and in order to make a development, it is necessary to find the true length of these lines.

Divide the top of the plan view into the same number of equal parts as was taken in the profile, Fig. 151, and number same from *a"* to *w"* corresponding to the same numbers as in the profile. Connect the points *a"* to *w"* with the points 1' to 20' of the plan, Fig. 150, with solid and dotted lines as shown.

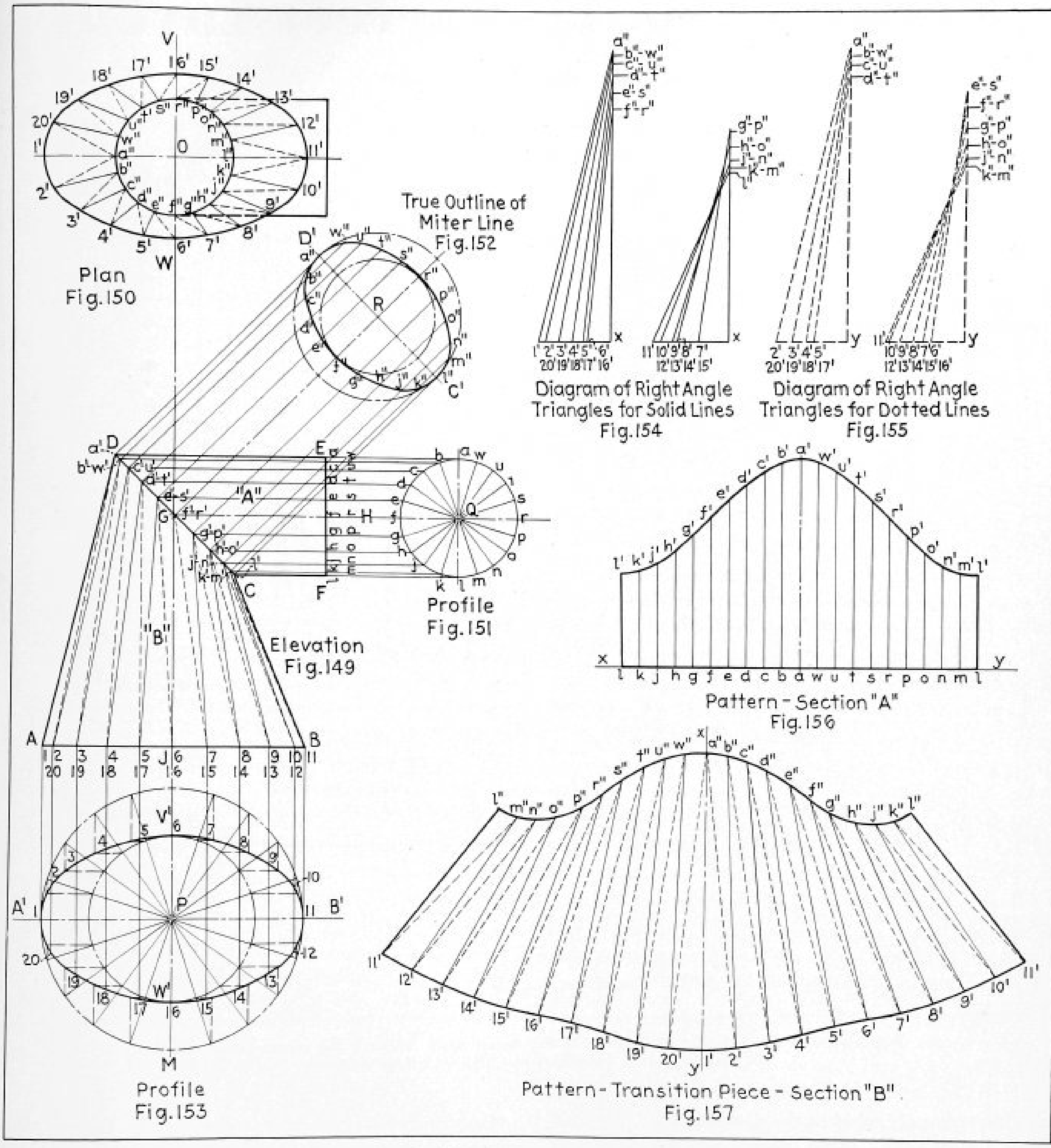
In order to obtain the true lengths of the surface lines of the transition piece as shown in the elevation, Fig. 149, it is necessary to erect a series of right angle triangles as shown in Figs. 154 and 155.

In Fig. 154, draw a line and erect a perpendicular to it at *x*. On the perpendicular, step off the distance *x-a"* equal to the vertical distance from the line *A-B* to the point *a'* in the elevation, then on the base line, step off the distance *x*-1' equal to the distance *a"*-1' of the plan, connect the points *a"*-1' with a line. This line will be the true length of the solid surface line 1-*a'* in the elevation, Fig. 149; then on the perpendicular, step off the distance *x-b"* equal to the vertical distance from the line *A-B* to the point *b'* in the elevation. On the base line, step off the distance *x*-2' equal to the distance *b"*-2' of the plan, connect the points *b"*-2' with a line and this line will be the true length of the solid surface line *b'*-2 in the elevation, Fig. 149. Continue in this manner, making the altitudes *x-c"* to *x-w"* equal to the vertical distances from the line *A-B* to the points *c'* to *w'* in the elevation, Fig. 149, and the bases *x*-3' to *x*-20' equal to the distances *c"*-3' to *w"*-20' of the plan view, Fig. 150, thus completing all of the right angle triangles for the solid lines and obtaining the true lengths of all the solid surface lines in the elevation.

In like manner in Fig. 155, obtain the true lengths of all the dotted surface lines of the elevation. The altitudes *y-a"* to *v-w"* being taken equal to the vertical distances from the line *A-B* to the points *a'* to *w'* of the elevation, and the bases *y*-2' to *y*-20' being taken equal to the distances *a*-2' to *a*-20' of the plan view, Fig. 150. The hypotenuses of these triangles will then be the true length of the dotted surface lines of the elevation.

The next step is to obtain the true length of the profile of the miter line *C-D* as shown in Fig. 152. This is done by constructing an ellipse in the same manner as described for Fig. 153.

At *G* erect a perpendicular to *C-D* and at any point *R* erect a perpendicular to *G-R* extending same each side



Details of development of transition piece

of *G-R*. Then parallel to *G-R*, draw lines through the points *C* and *D* of the elevation, extending same, cutting the line just drawn and locating the points *C′* and *D′*. Draw the line *C′-D′*, Fig. 152. *C′-D′* is the long diameter of the ellipse and the distance *E-F* of the elevation will be the short diameter of the ellipse. With the long and short diameters being known, construct the ellipse as described in Fig. 153. This ellipse will be the true profile of the miter line *C-D*.

Then draw lines parallel to *G-R* through the points *a′* to *w′* of the elevation, Fig. 149, extending same into the profile, Fig. 152, cutting the ellipse just constructed and locating the points *a″* to *w″*, Fig. 152.

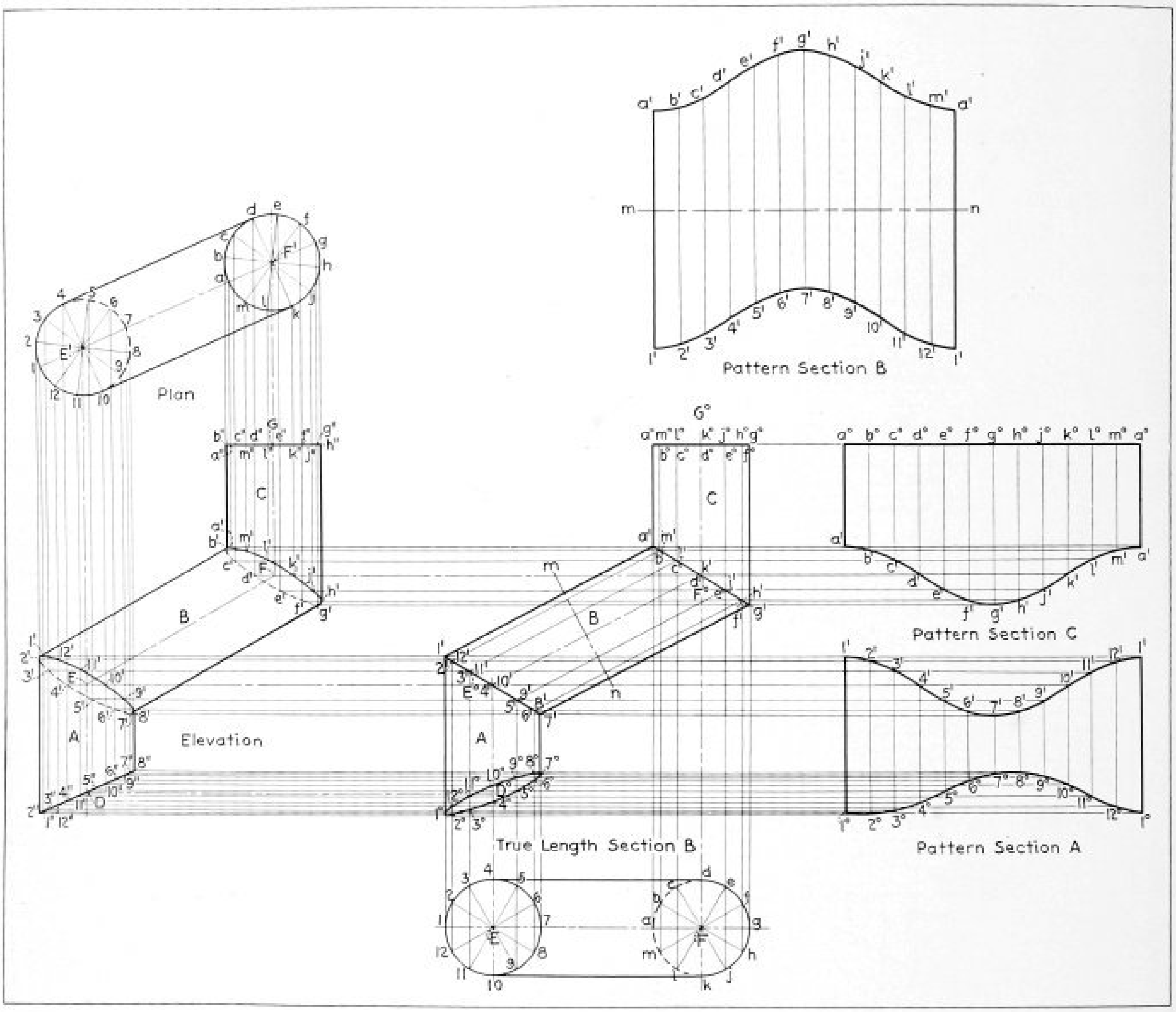
Pattern for Section "B"

Draw any line as *x-y*, Fig. 157, and on this line, step off the distance 1′-*a″* equal to 1′-*a″*, Fig. 154, and then with 1′ as a center and with the dividers set equal to the distance 1′-2′ of the plan view, Fig. 150, scribe an arc. Then with *a″* as a center and with the trams set equal to the distance *a″*-2′, Fig. 155, scribe a second arc cutting the arc just drawn and locating the point 2′, Fig. 157.

Then with *a″*, Fig. 157, as a center and with the dividers set equal to the distance *a″-b″*, Fig. 152, scribe an arc, and with the point 2′, Fig. 157, as a center and

Problem No. 13—Correct Layout

Oblique Pipe Intersection



Problem No. 13 was published on page 216 of the August issue. Above is the correct layout, which will serve as a check for readers who have worked on the problem

with the trams set equal to the distance $2'$-b'', Fig. 154, scribe a second arc cutting the arc just drawn locating the point b'', Fig. 157.

Continue in this manner until the line l''-$11'$ is drawn, making the distances, $2'$-$3'$, $3'$-$4'$ to $10'$-$11'$ equal to their corresponding distances in the plan view, Fig. 150, and making the distances b''-c'', c''-d'', to k''-l'' equal to their corresponding distances in Fig. 152. The lengths of the solid and dotted surface lines are taken equal to their corresponding lines in Figs. 154 and 155.

Then starting at the points a''-$1'$ continue in like manner on the opposite side, completing the pattern of the transition piece "B."

Draw any line as x-y, Fig. 156, and step off the same number of spaces as was taken in the profile, Fig. 151, these spaces being equal in length to the spaces taken in the profile, Fig. 151. Number the spaces from l to a to l as shown.

Construction of the Pattern of Section "A"

Erect perpendiculars to the line x-y at the points l to a to l on the perpendicular at the point l, step off the distance l-l' equal to the distance l-l' of the elevation, Fig. 149, and on the perpendicular to the point k, step off the distance k-k' equal to the distance k-k' of the elevation, Fig. 149. Continue in this manner, making the distances j-j', h-h', g-g', f-f', e-e', d-d', c-c', b-b', a-a', w-w' to l-l' equal to their corresponding distances in the elevation, Fig. 149. Connect the points l'-a'-l' with a line completing the pattern of section "A".

For convenience, all the outlines of the transition piece have been taken on the neutral diameters of the plates and the thickness of the plates omitted. The joint between the transition piece and the connection is to be welded and no lap is shown on either pattern.

(To be continued)

Meeting of American Welding Society

High-speed motion pictures taking 1200 exposures a second are revealing the phenomena of flash welding, William E. Crawford and Walter Richter, of the A. O. Smith Corporation, Milwaukee, Wis., reported in a paper presented before the American Welding Society, at its annual meeting held in Cleveland, October 19 to 24.

It has always been a question, what happens during flash welding, wherein the surfaces of the two steel parts to be joined are brought to incandescence by means of powerful electric flashes. When the surfaces are at the melting point, usually a matter of two or three seconds, the parts are welded by being pressed together. To the observer, flash welding consists of a series of blinding flashes, and a shower of incandescent particles flying in all directions. One of the most extensively used welding processes, it finds its major application in the fabrication of all-steel automobile bodies.

Edge-on motion pictures of flash welding mild steel show that the flashing operation is not characterized by a condition of uniform arcing. An arc forms momentarily at the point of contact of the surfaces, to be extinguished in a small fraction of a second and replaced by another arc at some other point of contact. During the period of single flash or arc there occur at irregular intervals violent expulsions of incandescent particles of steel.

"The important discovery is that each expulsion or shower of incandescent material occupies only a very limited duration of time, about one five-hundredth of a second," the authors said. "The expulsion may occur from both sides of the contacting surfaces simultaneously or may be confined, in unusual cases, to one side.

"The motion pictures of the flash are being studied in conjunction with records of an oscillograph which indicates the wave forms of the alternating current consumed by the flash. When the results of the experiments made by the formidable combination of high-speed motion picture camera and oscillograph are completely analyzed, scientific information of the highest importance to the development of flash welding may be expected."

A new pipe welding process was announced by R. M. Rooke and F. C. Saacke, of the Air Reduction Sales Company, New York. The oxy-acetylene weld metal is deposited in several layers instead of the one usually employed, resulting in a 500 percent increase in toughness and ductility, according to experiments. In practice, the multi-layer method simplifies many of the welder's difficulties, it is asserted.

Arthur N. Kugler, of the Air Reduction Company, discussed the application of the process to pipe joints in steam and electric power plants.

"Oxy-acetylene welds in steel are made by depositing steel melted from a welding rod into the space between the two objects to be joined, in this case pipes from 2 to 20 inches in diameter, ¼ to 2 inches thick," the engineers explained. "The welding rod and edges of the pipe are melted by means of a torch fed with a mixture of oxygen and acetylene under pressure and in correct proportions. The temperature of the flame is about 6000 degrees F., far above the melting temperature of steel, which is about 2700 degrees F.

"In welding heavy-wall steel pipe the weld should be made in more than one layer. First a thin layer of weld metal from 2 to 6 inches long is deposited in the bottom of the groove between the two pipes to be joined. After this layer has cooled below a red heat another layer is deposited; and so on until the entire groove between the plates is filled and the weld is completed. For a pipe 1 inch thick, four layers are usually sufficient, the last layer deposited being as thin as possible.

"Although the multi-layer method may seem at first more complicated than the single-layer method, tests have shown that the reverse is the case in practice. The man who welds pipe lines is a skilled operator. He must be able to manipulate a pool of molten steel not only in the flat or horizontal position but also in the vertical and overhead positions. The welder when making a weld in the vertical position has to prevent the molten metal from flowing or dripping away from the weld.

"In the overhead position the welder must possess even greater skill than in the vertical position. His problem may be compared with painting a ceiling. The trick consists in manipulating the brush so that the ceiling is painted and not the floor. The welder's position is far more difficult than the painter's because the welder's fluid is heavy molten steel. He must also direct an extremely hot flame with one hand while applying the welding rod with the other.

"Simplification by the multi-layer welding method involves a speeding up of the process so that multi-layer welds are quicker to make than single-layer welds. The multi-layer method also consumes less welding rod and fuel gases, oxygen and acetylene.

"The improvement in toughness of the multi-layer welds is due to the small size of the individual layers in multi-layer welds. A small layer of molten steel is deposited more rapidly and freezes more quickly than a large layer. The layers of a multi-layer weld are therefore exposed to contaminating influences of the atmosphere for a shorter time than single-layer welds. A further increase in ductility with very little sacrifice in strength is provided by the beneficial heat effect of succeeding layers of weld metal on cool welded steel. The heat effect is said to 'refine the grain' of the first layers of welded steel.

"In other words, the large crystals of steel of which a single layer of weld metal consists are broken up into much smaller crystals. For example, the length of an individual crystal of steel in a single layer weld may be as much as 0.1 inch. The heat effect of another layer of weld metal deposited on the original layer reduces the size of the individual crystals to approximately one ten-thousandth of an inch. In this way a few large crystals are replaced by myriads of small crystals with a resulting improvement of up to 500 percent in toughness and ductility."

Changes in the architecture of steel during welding were described and illustrated with photographs by E. S. Davenport and R. H. Aborn of the United States Steel Corporation. The photographs were prepared by means of a microscope capable of enlarging the structure up to 1500 times.

The welds in steel were shown to be surrounded by two zones: one softer than the original steel, the other harder and more brittle. In ordinary steels the hard and soft zones are very little, if at all, different from the original steel. In some alloy steels containing copper, nickel, chromium, or other alloying elements, the hard zone is found too hard and the soft zone excessively soft.

Explaining metallurgical principles of welding by which difficulties experienced with troublesome steels may be overcome, Mr. Davenport and Mr. Aborn pointed out that strength and toughness of a weld are developed during the quiet cooling of the white hot molten steel.

"The valuable combination of strength and toughness that is characteristic of steel and of welds in steel is largely a product of the changes that take place in the internal structure of steel at temperatures between normal room temperature and a dull red heat.

"At ordinary temperature, steel, which is iron containing up to 1.5 percent of carbon, is normally a mixture of a soft material called ferrite, nearly pure iron, and an extremely hard material called cementite, a chemical compound of iron and carbon. Steels normally tend to be composed of ferrite and cementite mixed together as minute plates seldom more than one 0.025 inch in thickness.

"If, however, the steel is cooled very rapidly from a dull red heat, by dipping in water, for instance, the mixture of hard and soft materials may be replaced by a single material known as martensite, which is hard and brittle. Had the steel been heated just below a dull red heat, known as the critical temperature, before being dipped in water, the steel would actually have been slightly softened instead of hardened.

"The multiplicity of changes occurring in steel during welding give rise to five distinct zones. The conditions of welding are such that the steel in and adjacent to the weld is heated to all temperatures up to the melting point and cooled rapidly. Some zones of the steel near the weld are heated just high enough so that, upon cooling, they are a little softer than the original steel. Other zones have been heated above a dull red heat and upon cooling become somewhat harder than the original steel.

"In the first case the cementite plates have become rounded into globules by being heated just below the critical temperature. In the second case, some of the steel tends to assume the hard, brittle form."

Miller Memorial Medal Award

As "pioneer and leader in a welding research movement which in nineteen years has spread to the far corners of the world and vitally affected industry," Henry Metcalf Hobart, consulting engineer of the General Electric Company, Schenectady, N. Y., was awarded the Samuel Wylie Miller Memorial Medal of the American Welding Society.

Mr. Hobart, chairman of the Fundamental Welding Research Committee of the Engineering Foundation, which is directing more than sixty welding researches in university laboratories, reported to the Emergency Fleet Corporation in 1917 a study of the application of welding to shipbuilding in Great Britain. This report marked the beginning of American research which is said to have developed welding into "the most important and most widely used tool of industry."

"Mr. Hobart since 1917 has done a vast amount of significant research work," the citation of the Medal Committee pointed out. "In presenting the medal to Mr. Hobart for his outstanding services in the advancement of welding research, the society gives recognition to one of the most faithful workers in the cause of cooperative research.

"Largely through the untiring efforts of Mr. Hobart, the number of professors in the various universities of this country interested in welding research have grown from four or five to more than sixty."

Mr. Hobart developed mercury arc rectifiers, and is an authority on arc welding, design of dynamo-electric machinery, insulation, and standardization. He is active in promoting international and national electrical standardization, and is a member of the U. S. National Committee of the International Electro-Technical Commission.

A founder and director of the American Welding Society, Mr. Hobart is also former vice-president of the American Institute of Electrical Engineers, and a Fellow of the American Association for the Advancement of Science. He is a member of the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Institution of Electrical Engineers, all of Great Britain. He has represented the Welding Society on the Engineering Division of the National Research Council.

Mr. Hobart was born in Boston, November 29, 1868. He was graduated from Massachusetts Institute of Technology in 1889. For five years following his graduation, he was connected with the Thomson-Houston Company and later with the British company of the came name, resigning in 1899 to become consulting engineer with the Union Elektricitäts Gesellschaft, Berlin. In 1902 he established an independent consulting practice in London, continuing until 1911, when he became associated with the General Electric Company.

He is the author of numerous scientific works, including "Electric Machine Design," "Continuous Current Dynamo Design," "Heavy Electrical Engineering," "Electric Railway Engineering," "Electric Trains," "Electric Propulsion of Ships," "Static Transformers," "Design of Polyphase Generators and Motors," and "Electric Motors." He is editor of a Dictionary of Electrical Engineering.

Election of Officers

Election of Alfred E. Gibson, vice-president of the Wellman Engineering Company, Cleveland, as president of the American Welding Society to succeed J. J. Crowe of the Air Reduction Sales Company, Jersey City, N. J., was announced. Mr. Gibson will aid in administering a world program of welding research in association with the Engineering Foundation, research organization of the national engineering societies which was founded by Ambrose Swasey of Cleveland twenty-two years ago.

Mr. Gibson is a native of Toronto, Canada, and was graduated from Ohio State University in mechanical engineering in 1909. He is a former president of the Fulton Foundry and Machine Company. Mr. Gibson has done notable research in the field of low-alloy high-strength steels. He is a member of the American Society of Mechanical Engineers, the Society for Metals, and the Iron and Steel Engineers.

E. R. Fish of the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn., was elected senior vice-president of the society. Divisional vice-presidents were chosen as follows:

New York and New England Division, John H. Zimmerman of the Massachusetts Institute of Technology.

Middle Eastern Division, R. D. Thomas of R. D. Thomas and Company, Philadelphia.

Middle Western Division, H. C. Boardman of the Chicago Bridge and Iron Works, Chicago.

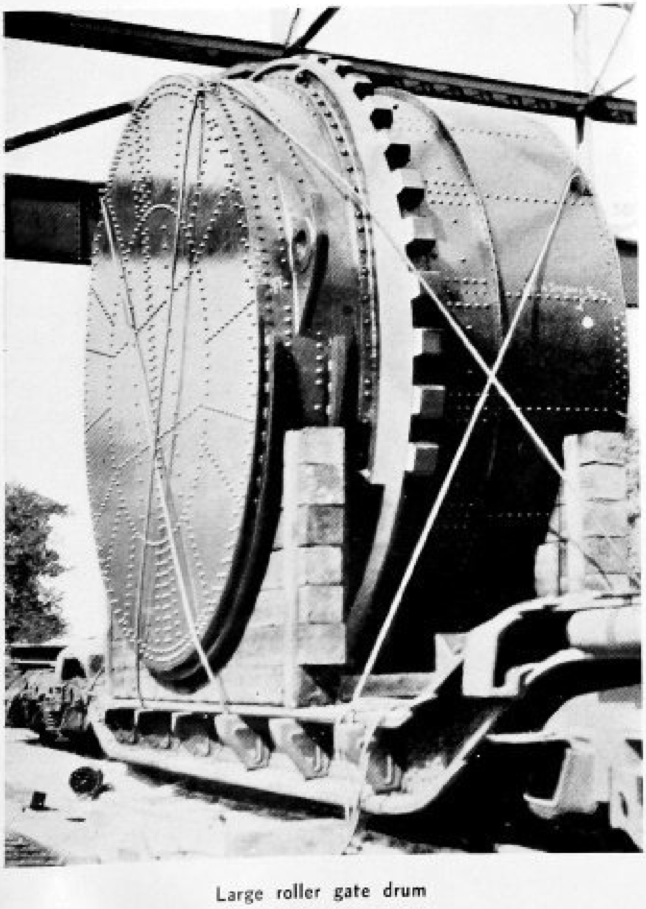
The following directors were named: Ira T. Hook, American Brass Company, Ansonia, Conn.; G. A. Hughes, Truscon Steel Company, Youngstown, O.; R. E. Kinkead, Cleveland; H. S. Smith, Union Carbide Company, New York; Andrew Vogel, General Electric Company, Schenectady.

Nearly fifty papers and addresses were presented before the Cleveland sessions of the society, which continue for five days and in connection with which a welding exhibition was held. Engineers and executives from the steel and iron, copper, nickel, chemical, automobile, machinery, petroleum, electrical, shipbuilding, construction, and other industries participated.

A Record Rail Shipment

Here's a case of "low bridge," and a cargo that couldn't duck. The illustration shows one of twenty end drums for the roller gates in No. 5 and No. 7 Mississippi Flood Control Dams that were fabricated at the Leetsdale shops of the Bethlehem Steel Company.

They were shipped from Leetsdale, which is near Pittsburgh to Winona and Dresbach, Minn., in a special type of Pennsylvania Railroad depressed car. The overall diameter of the two types of drums included in the shipments was 16 feet 8 inches. But as loaded on the depressed cars each cargo measured 19 feet in height from the top of the rails. And getting the drums to their destination was mostly a problem of working out a route that had no bridges or water spouts low enough to interfere with their passage. But one such route, as given below, was found. It was as follows:


Large roller gate drum

Pennsylvania Railroad via Conway, Pa., to Salem, O. Over main track only under Main St. Bridge to Alliance, O. To Crestline, O., and Adams, Ind. To Ridgeville, Ind., Logansport, Ind. Remove water spouts at Lake Ciecott, Ind. Water spouts at Remington and Effner, Ind., must be pulled to their highest position.

To Toledo, Peoria and Western Railroad at Effner, Ind., to Webster, Ill., for delivery to C.M. St. P. and P. Railway via that line to Joliet, Ill., for delivery to E. J. and R. Railroad. This line moved cars to Spaulding, Ill., for re-delivery to C.M. St. P and P. Railway and movement to destination. Movement restricted to local train service at a speed not to exceed 30 miles

A.S.M.E. Annual Meeting

Plans to improve the quality and member interest in the Annual Meeting of The American Society of Mechanical Engineers, to be held in New York, N. Y., November 30 to December 4, are under way and the technical program is rapidly taking final form.

As a result of a quickened interest in the problem of presenting a multitude of technical papers on the part of the Committee on Meetings and Program and the Committee on Professional Divisions, this year's program will be arranged with a minimum of simultaneous technical sessions so that members whose interests are in many subjects will find it less difficult to avoid conflicts in their personal schedules. In order to accomplish this desirable objective, recourse is being had to two evening sessions, scheduled for Monday and Thursday, and to an increased number of gatherings, some combined with luncheons, at which the panel method will permit discussion of present trends and topics of interest in general and special fields.

It is expected that the evening sessions will provide an opportunity for the attendance of younger men whose duties make difficult their participation in sessions held during working hours. One of the two evening sessions to be conducted on Monday, November 30, will be devoted to a paper on the "Steamotive," a complete steam-generating unit, its development, and test. The paper describing this new device has been prepared by E. G. Bailey, of the Babcock & Wilcox Company, A. R. Smith, of the General Electric Company, and P. S. Dickey, of the Bailey Meter Company.

The other session on Monday evening will consist of a symposium on the latest developments in time and motion study and is being organized by Professor D. B. Porter, of New York University.

On Thursday evening one of the sessions will be given over to the presentation of three papers dealing with the early history in this country of the steam turbine. Three papers will be devoted to the Westinghouse, the Allis-Chalmers, and the General Electric turbines, and will be presented by E. E. Keller and Francis Hodgkinson, A. G. Christie, and A. R. Smith, respectively.

Simultaneously with the symposium on turbine history, the concluding session on corrosion-resisting metals, a feature of the Annual Meeting, is scheduled.

In addition to the evening session already noted, two daytime technical sessions in the symposium on corrosion-resisting metals have been arranged for Thursday morning and afternoon.

The information presented is to be in compact form, of a practical nature, free from lengthy theoretical discussions but still sufficiently complete so that when the different papers are assembled they will form a handy reference for the engineer on the subject of corrosion-resistant metals.

The need for such a symposium was expressed by designing and operating engineers of the country who are constantly confronted with many problems on corrosion. They are busy men and not many of them have been able to follow closely the rapid development of this type of information during the past few years. Several of the professional divisions of the society joined in developing the symposium. T. H. Wickenden, past-chairman of the society's Iron and Steel Division, was appointed chairman of the Committee that is arranging the symposium.

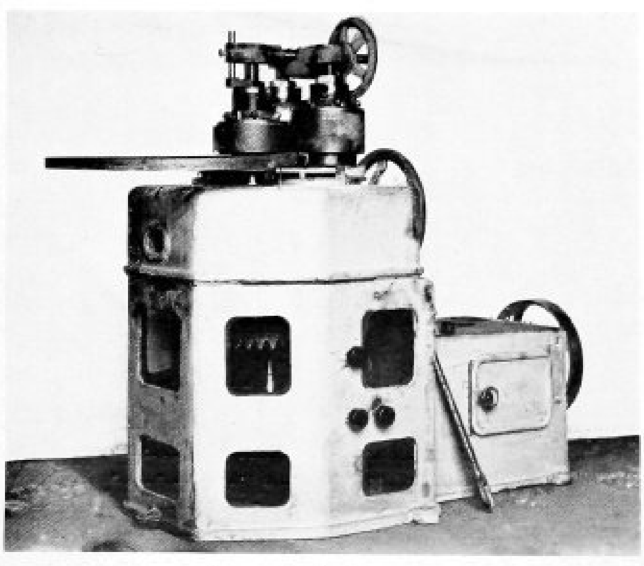
Technical Sessions of the Divisions

Technical sessions of the society's professional divisions will make up the bulk of the daytime program. Among the topics discussed are: Aero-dynamics, fuels, applied mechanics, boiler feed water, heat transfer, safety, cinder catchers, fluid meters, railroad engineering, thermodynamics, power, cutting of metals, textile drying, Diesel engines, steam turbines, control instruments for steam turbines, mechanical and rubber springs, quieting of machinery, with a demonstration lecture, bearings, layout and equipment of plants, hydraulics, and the cleaning of coal.

The technical program is still in tentative form, and whether or not the wealth of material available can be fitted into the limitations of time and meeting rooms remains to be determined.

New Design Feature in Angle Bending Rolls

The "Schatz-Herkules" machines for rolling angles, tees, beams, channels, flats, etc., are being introduced by the Schatz Manufacturing Company, Poughkeepsie, N. Y. These are available in various sizes, for bending the smallest angle and up to 8-inch by 8-inch by 1-inch. They have a unique feature in that the rolls are adjustable for rolling the different profiles, eliminating the necessity of interchanging the rolls.

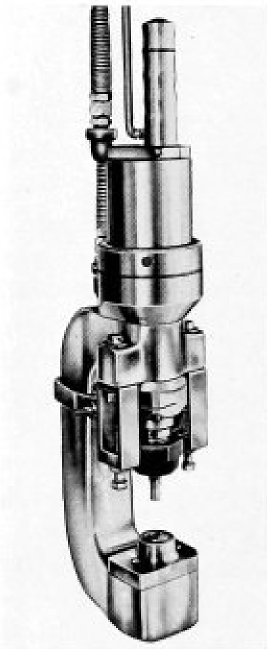


New angle bending rolls

The accompanying illustration shows sizes BO-8 and BO-9 for rolling up to 2-inch by 2-inch by ¼-inch and 2½-inch by 2½-inch by 5⁄16-inch angles respectively. The horizontal operation permits the easiest and safest handling of the longest bars and largest rings. The guide rolls have both vertical and radial adjustment and finished rings are easily removed. These machines may be had for either unit electric drive or belt drive.

Portable High Speed Hydraulic Punch Developed

Hannifin Manufacturing Company, Chicago, has recently delivered to a manufacturer of metal products a new type of high speed portable hydraulic punch for semi-automatic handling of a range of punching operations.



Hydraulic punch

This portable unit weighs 59 pounds, and has a capacity of 17½ tons. Dies are interchangeable, providing for punching holes of various diameters up to ⅞ inch in drawn and formed parts of sheet steel up to 10 gages. The yoke is provided with shoulders for attachment of an adjustable stripper for automatic removal of shells of various depths. The operating cycle is approximately 2 seconds.

The punch is operated by hydraulic power from a pressure generator consisting of motor-driven oil pump, automatic electric valve unit, and oil reservoir. The portable punch is connected to the pressure generator unit by high pressure hoses and electrical control cable. A push-button on the handle of the punch controls the entire operation of the unit.

Exclusive safety features are provided. The punch will not repeat, but completes one cycle and stops. The control button must be released and pressed again for another cycle. Release of the control button at any point during the operating cycle provides an instantaneous safety stop with automatic return to starting position.

Republic Steel Appoints Assistant Sales Manager

R. H. Sonneborn has been named assistant manager of sales, pipe division, of Republic Steel Corporation, Cleveland, according to an announcement by N. J. Clarke, vice-president in charge of sales. Mr. Sonneborn was formerly special representative and assumes the position vacated by the appointment late last year of George E. Clifford to the position of district sales manager at Los Angeles, and more recently by Charles W. East, district manager of the Houston district. Martin I. Shea will continue as the other assistant manager in the pipe division, which position he has held for the past eight years.

Proposed Revision of A.S.M.E. Code for Unfired Pressure Vessels

The A.S.M.E. Boiler Code Committee contemplates a complete revision of Section VIII of the A.S.M.E. Boiler Construction Code which covers construction of unfired pressure vessels.

The special committee appointed for this purpose desires to obtain criticisms and suggestions on the following numbered items. The proposed revision scheme and the details have been tentatively agreed upon by the special committee except for the factor of safety, the stress-relieving requirements, and the limitations. The use of a factor of safety of 4½ instead of 5, as in the present A.S.M.E. Unfired Pressure Vessel Code (item 8), the stress-relieving requirements (item 10), and the limitations (items 13, 14, and 15) in the proposals given below have not been agreed upon by the special committee. It is anxious to obtain as many criticisms and suggestions as possible on these points in particular. Communications should be sent to the secretary, Boiler Code Committee, 29 West 39th Street, New York, N. Y.

Proposed Revision Plan.

(1) That the revised Unfired Pressure Vessel Code be divided into two parts tentatively designated as Parts 1 and 2.

(2) That Part 1 comprise the present Section VIII revised so that it will follow the same general arrangement as the API-ASME Code for Unfired Pressure Vessels and also in certain other details, the allowable working stresses to be made less than in Part 2. Separate rules will be given in Part I for fusion-welded vessels now covered by Par. U-70, following in general the present rules of the A.S.M.E. Code.

(3) That Part 2 embody the additional requirements, such as a mandatory inspection section, which justify a factor of safety of 4, and that the requirements of Part 2 be made identical with those of the API-ASME Code.

Proposed Revisions Applicable to Fusion Welding Under Part I.

(4) That reference to Pars. U-68, U-69, and U-70 be eliminated. For purposes of discussion and offering comments on the revisions, the types of vessels covered by these paragraphs are tentatively referred to in what follows as *A*, *B*, and *C*.

(5) That in the beginning of the revised code a statement be included outlining the limitations of the different types of vessels, if any; namely, what vessels must be both X-rayed and stress relieved.

(6) That vessels be required to be stamped with the pressure and temperature limitations, and when stress relieved and radiographed with the letters "SR" and "XR," respectively.

That the requirements in the following numbered paragraphs of the API-ASME Code be incorporated in proposed Part 1, except as indicated.

(7) *Par. W-201.* Omit part which states that when the vessel is to be stress relieved after welding, the test coupon before testing shall be stress relieved, etc.

(8) *Par. W-309.* Change caption for "s" to make it read:

s = maximum allowable unit working stress from Table — for *A* and *B* vessels (the stresses in the table to correspond to a factor of safety of 4½). The value of "s" for *B* vessels in which the shell thickness is ⅝ in. or less, shall not exceed 11,000 lb per sq in., irrespective of the strength of the material.

(9) *Par. W-313.* Omit first paragraph bearing on location of openings in heads.

(10) *Par. W-318.* Revise the rule which bears on stress relieving of fusion-welded vessels when constructed of other than steel complying with A.S.T.M. Specification A-149 and A-150 to make it read:

"Vessels shall be stress relieved when the ratio of the inside diameter to the cube of the shell thickness in inches at any welded joint of the shell or head plate is less than R,

where:

$R = 100$ for shell diameters of 50 in. or less,

$R = 150 - D$ for shell diameters of 50 in. to 100 in., where D = shell diameter in in.,

$R = 50$ for shell diameters of 100 in. and over."

Retain the present requirement of the API-ASME code that vessels shall be stress relieved when the plates are over 1¼ in. in thickness at any welded joint.

(11) *Par. W-329.* Modify to allow the 2-in. deduction in diameter as in the A.S.M.E. Code rules.

(12) *Par. W-521.* Make the requirements for bend tests read:

". . . shall be at least 30 percent for *A* vessels; for *B* vessels the elongation shall be at least 30 percent for stress-relieved welds, and 20 percent for unstress-relieved welds. For *C* vessels the elongation shall be at least 10 percent."

Proposed Limitations for the Different Types of Vessels.

(13) Fusion-welded *A* vessels shall be both radiographed and stress relieved. These vessels may be used for any purpose when constructed in accordance with the rules in this Code.

(14) Fusion-welded *B* vessels need not be radiographed. They shall be limited to a maximum thickness of 1½ in. and shall not be operated at pressures in excess of 400 lb. per sq. in., except that in the case of vessels operated under hydraulic pressure at atmospheric temperature, the pressure limitation shall not apply.

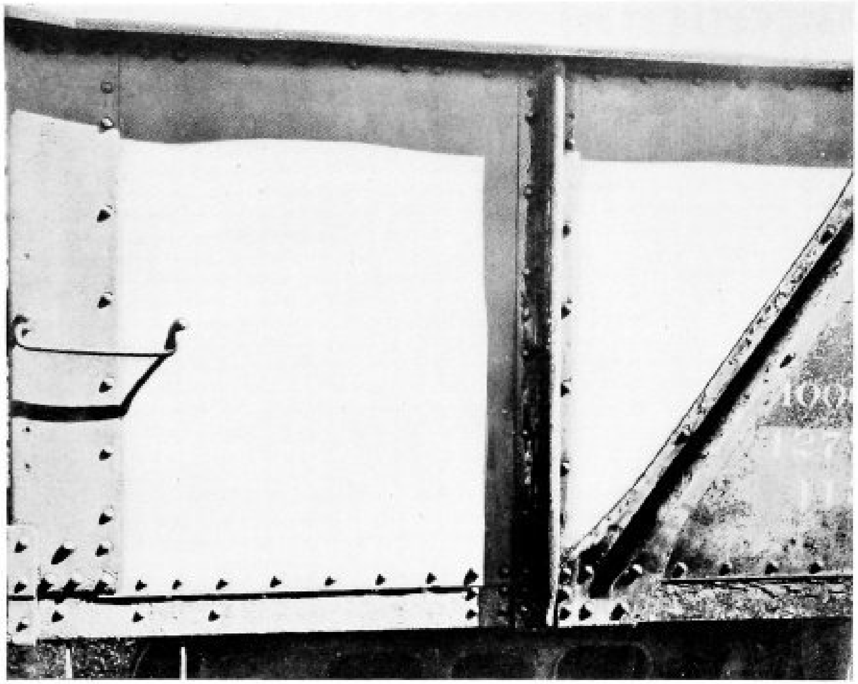
These vessels may be used for any purpose except for containing:

(1) Lethal liquids or gases.

(2) Other liquids at temperatures above 350 F.

(3) Other gases at temperatures above 700 F.

(15) Fusion-welded *C* Vessels when constructed in accordance with the rules in the Code may be used for the storage of gases or liquids, except lethal gases or liquids, at temperatures not materially exceeding their boiling temperature at atmospheric pressure and at pressures not to exceed 200 lb. per sq. in., and/or not to exceed a temperature of 250 degrees F. Plate thickness shall not exceed ⅝ in.



Unretouched reproduction of photograph of Coppercote test taken on July 25, 1936, on Long Island, after fifteen months of exposure to the full effect of the sun's rays, ocean fogs, and winter storms. The surface shows the original gloss with no indication of rust breaking through the surface at any point. Corrosion has been stopped completely

Preservative Coating Stops Corrosion

Pure metallic copper of extreme fineness and of the irregular flaky structure known as "dendritic" can now be applied to iron, steel, wood, concrete, or other surfaces which require a protective coating of unusual effectiveness. This new coating being produced under the name Coppercote has been thoroughly tested in the solution of many difficult corrosion problems. It is being placed on the market by American Coppercote, Inc., 480 Lexington Avenue, New York.

Corrosion in its various forms costs the American people approximately three billion dollars a year according to the U. S. Bureau of Foreign and Domestic Commerce. Statistics compiled by the Journal of the West Scotland Iron and Steel Institute show that for a period of thirty-four years under review, 40 percent of the entire production of pig iron was consumed by corrosion.

The development of Coppercote involved the production of a special vehicle in which the minute flakes of pure metallic copper remain in perfect suspension. While the coating is being applied, a physico-chemical reaction occurs between the particles of copper and its vehicle. Since the copper is "dendritic" in structure rather than granular, a closely knit coating results which, when set, forms a tough hard metallic surface. When applied to a surface of ferrous metal it will positively prevent corrosion. When applied to a surface already rusted, it will arrest any further corrosive action. It will not crack, scale nor chip as a result of the extremes of temperature nor is it affected by the ultra violet rays of the sun.

A turbulent action which takes place when Coppercote is applied causes it to spread itself automatically and to work its way into every pore of the coated surface to which it becomes thoroughly united. The result is a sealed metallic surface claimed to be permanently impenetrable by either air or moisture and therefore a positive protection against corrosion. This action throws off every air bubble and closes every pin hole, but more important than this, there occurs a definite stratification of the metallic copper and its vehicle. The copper particles combine and adhere closely to the base while the vehicle rises and forms a second protective film. This phenomenon permits the use of various colors in the vehicle.

Coppercote has been demonstrated to be a non-conductor of electricity. Due to the insulative character of the coating, destructive electrolytic action is impossible.

Many severe tests covering a period of several years have demonstrated that Coppercote is a most effective preservative coating suitable for a great variety of surfaces and conditions. A few examples are mentioned, as follows:

Deeply corroded specimens of angle iron were treated with Coppercote and buried in coal cinders for one year. At the end of this period they were unearthed and found to be in perfect condition.

Steel specimens coated with Coppercote were buried in alkaline soil for two years. When dug up, they were found to be unaffected.

A heavy steel test specimen was treated with Coppercote and attached to a pier in Long Island Sound in such a position that at low tide the specimen was exposed to the elements and to the sun while at high tide it was completely submerged. This test was carried on for a number of months and at its conclusion the specimen was found to be in perfect condition.

The test illustrated above to determine the corrosion resistance of Coppercote was conducted on a badly rusted gondola car lying in the railroad yards on Long Island, N. Y. The test was started on April 30, 1935. The heavy scale on two end panels was chipped off and the corrosion burned onto the plates with a blow torch. Two coats of Coppercote were then applied. On July 25, 1936, the above photograph was taken with the results outlined in the caption.

It has been demonstrated that the application of Coppercote to wooden structures provides effective protection against the termite and also against marine borers including the teredo and limnoria.

Lee M. Hogan

Irving Whitehouse

Lee M. Hogan Made District Sales Manager of Steel and Tubes, Inc.

W. J. Sampson, Jr. vice-president in charge of sales has announced the following appointments in the sales department of Steel and Tubes, Inc., Cleveland.

Lee M. Hogan, former manager of advertising and sales promotion, has been named district sales manager of the New York District. Irving Whitehouse, former assistant manager, becomes manager of sales promotion.

A. R. Smith, who has been superintendent of the Elyria division of Steel and Tubes, was promoted to general manager of that division upon the retirement of A. E. Adams.

Mr. Hogan was born in Salina, Utah and later came East to enter Columbia University. After several years' study there in philosophy and psychology, he entered industrial engineering and was graduated from New York University and Brooklyn Polytechnic in that department. He began his active career in the steel industry in 1923 with the Mohegan Tube Company of Brooklyn which was later destined to become part of the Republic Steel Corporation. Mr. Hogan came to Cleveland in 1927 and through the various mergers, worked up in the sales department to the position he has recently vacated to accept his present appointment.

Mr. Whitehouse is a graduate of Yale and Massachusetts Institute of Technology and as a sales engineer, in the two years he has been with Republic, advanced to the position he has just accepted.

A. R. Smith began his present connections in 1920 with companies which were later to become part of Republic and rose through the sales and operating departments to become superintendent and recently general manager of this division.

A.S.M.E. Boiler Code Addenda

The Boiler Code Committee of The American Society of Mechanical Engineers, New York, has recently prepared an additional set of addenda to the A. S. M. E. Boiler Construction Code with reference to locomotive boilers, power boilers, miniature boilers, low-pressure heating boilers, unfired pressure vessels, material specifications, specifications for electric resistance welding of steel and open-hearth iron boiler tubes, specifications for seamless alloy-steel pipe for service at temperatures from 750 to 1100 degrees F. and specifications for forged and rolled alloy-steel pipe flanges, forged fittings, and valves and parts for service at temperatures from 750 to 1100 degrees F.

New Books

Steam Boiler Rules. Fourteenth edition. Formulated by the Board of Boiler Rules, Department of Public Safety, Commonwealth of Massachusetts. Size, 5¾ by 9 inches. Pages, 219. Boston, 1936: Commonwealth of Massachusetts, Department of Public Safety, Board of Boiler Rules.

This book is the latest edition of boiler rules prepared by the Commonwealth of Massachusetts for the guidance of inspectors, operating engineers and boiler constructors, who follow the Massachusetts boiler regulations.

Wrought Iron: Its Manufacture, Characteristics and Applications. By James Aston and Edward B. Story. Size, 6 by 9 inches. Pages, 59. Illustrations, 29. Pittsburgh, Pa., 1936: A. M. Byers Company. Price, $1.

This small compact book fulfills a long-felt need for an up-to-date authoritative treatise on the subject of wrought iron. Its title aptly describes the major contents of the book which are presented clearly and concisely with frequent use of photographs for clarification. Several tables are included which give the chemical content, age and service history of wrought-iron equipment and appliances.

Procedure Handbook of Arc Welding Design and Practice. Fourth edition. Size, 5½ by 8½ inches. Pages, 819. Illustrations and figures, 990. Numerous tables. Cleveland, O., 1936: The Lincoln Electric Company. Price, $1.50 in the United States and $2 elsewhere.

The fourth edition of the Procedure Handbook contains the usual mine of information dealing with welding that has characterized previous editions but progress in the welding industry is so rapid that a new edition is made necessary which will include some of the latest and important developments. Some of these are atomic hydrogen air welding, characteristics of the welding generator, improvements in weld technique, methods of testing weld metals, weldability of 4-6 chrome steel, monel metal and nickel, and methods of design for welding.

Trade Publications

Welding Technique.—The Lincoln Electric Company, Cleveland, has recently prepared a booklet describing the application and operating characteristics, as well as the construction of the recently developed shield arc S. A. E. welder.

Fabricated Process Equipment.—The Edge Moor Iron Works, Edge Moor, Del., has published an illustrated bulletin describing some of the special equipment for process industries, and watertube boilers, fabricated at the Edge Moor Works.

Efficient Heat Transfer.—The Dow Chemical Company, Midland, Mich., has prepared a booklet entitled, "Dowtherm for high-temperature heat transfer systems." This publication is a compilation of data related to the efficient transfer of high-temperature heat and includes a discussion and description of "Dowtherms" and their application in modern power plants.

Nickel and Nickel Alloys.—The Fall edition of *Inco*, a publication of the International Nickel Company, Inc., New York, contains articles on oil-well drilling machinery, valve construction, condenser tubes and air-conditioning appliances. Smaller articles are included describing various devices which employ nickel or a nickel alloy in their construction.

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

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Contents

Studying Tube Arrangement

By N. Gouljalft

When designing water and oil heaters, boilers and apparatus for the chemical industry, one is often confronted with the question as to the best arrangement of tubes.

The tubes are placed either in straight rows (Fig. 1), or in zig-zag, or staggered rows (Fig. 2).

When the first method is used, the outer surface of the tubes is more easily accessible for cleaning, but in the second alternative the deflection of the liquid to be heated and circulation between the tubes makes for better utilization of heat. Furthermore, a greater number of tubes may be placed per surface unit, which makes the whole system more compact.

Let us designate by d the diameter of the tubes, and by p the shortest distance between the outer walls of two adjacent tubes. We see in Fig. 1 that on the surface $(d + p)^2$ can be placed four quarters of a tube; i.e., one tube. For placing two tubes we must have the surface $2(d + p)^2$.

It is evident from Fig. 2 that one tube may be placed on the surface expressed by the formula:

$$(d + p) \times (d + p)\sin 60 \text{ degrees} = 0.866 (d + p)^2,$$

where $(d + p)$ is the base of an isosceles triangle, and $(d + p)\sin 60$ degrees the elevation of this triangle.

Two tubes require a surface expressed by

$$2 \times 0.866(d + p)^2 = 1.73(d + p)^2.$$

The apexes of the above quadrangle lie at the centers of four adjoining tubes. On the surface $1.73(d + p)^2$

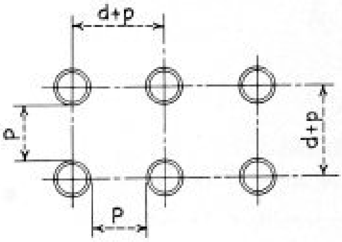


Fig. 1

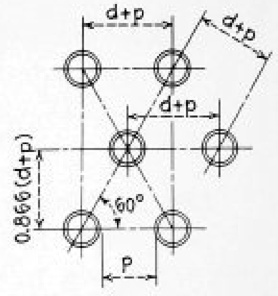


Fig. 2

can therefore be placed one tube and four quarters; i.e., two tubes.

Consequently, when arranging the tubes in zig-zag rows, the number of tubes on the given surface will be $\frac{2}{1.73}$ times more; i.e.,

$$\frac{(2 - 1.73)100}{1.73} = 15 \text{ per cent more tubes.}$$

The zig-zag or staggered arrangement is especially suitable for portable boilers, evaporators, condensers, etc.

When, however, forced draft is used and the tubes are very closely spaced (e.g., when $d = 2$ inches and $p = \frac{7}{8}$-inch to 1-inch), this arrangement of tubes is not entirely safe, as the steam that is abundantly developed between the tubes and cannot find its way out at once, adheres to the lower part of the tubes and may cause a local superheating of the tube plate, resulting in its bending.

The distance p depends upon the diameter of the tubes used and the thickness of the tube plate.

Example.

Tube diameter ......$d = 2$ inches
Distance ....$p = 3$ inches
When tubes are arranged in straight rows:
$2(p + d)^2 = 2(3 + 2)^2 = 2 \times 25 = 50$ square inches.
When tubes are placed in staggered rows:
$1.73(p + d)^2 = 1.73(3 + 2)^2 = 1.73 \times 25 = 43.25$ square inches.

Lukenweld Appoints New Officers

Everett Chapman, who has been vice president of Lukenweld, Inc., Coatesville, Pa., has been elected president of the company, according to an announcement by Robert W. Wolcott, president of Lukens Steel Company, of which the Lukenweld organization is a division. Chapman succeeds G. Donald Spackman, who was recently promoted to general superintendent of Lukens Steel Company. Robert J. Whiting, who has been superintendent of Lukenweld, Inc., in charge of all manufacturing, has been elected vice-president.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Copper Ferrules in Firetube Boilers

Q.—Being in need of some information about retubing of firetube boilers I am writing to you for same. I am going to help soon in retubing a locomotive crane boiler and since they have talked about it since last spring and with the cold weather coming on they are to retube it soon. I have had experience in boiler making as I worked on it for many years until I had to give it up on account of ill health. About 2 years ago when they were installing a high-pressure boiler here in a plant, one of the men took a contract to retube the boiler I am referring to and he did not put any ferrules in the tube sheet where the holes were not too big, particularly on the outside rows of tubes.

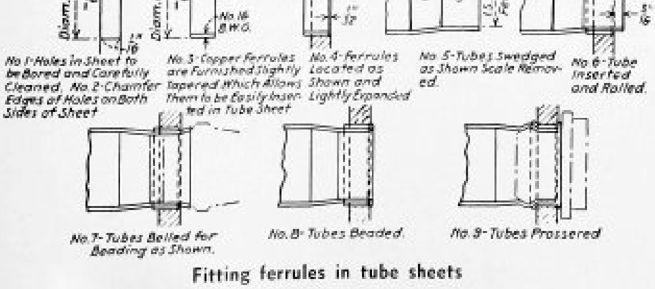
The tubes were put in just as they came from the factory and it seems as though they gave pretty good results. I have never in my experience in retubing boilers failed to use copper ferrules. Our usual procedure was to take a tube, heat and swedge it to a certain size and then try it on the tube sheet to get at an average swedge. I don't seem to be able to see how the tubes would hold any length of time. I have had quite an argument and I would appreciate some advice on this matter. T. R.

A.—The A.S.M.E. Code does not require the use of copper ferrules in firetube boilers (P-250). A firetube boiler shall have the ends of the tubes firmly rolled and beaded, or rolled, beaded and welded around the edge of the bead. When the tubes do not exceed 1½ inches in diameter, the tube sheet may be chamfered or recessed to a depth at least equal to the thickness of the tubes and the tubes rolled into place and welded.

In no case shall the tube end extend more than ⅜ inch beyond the tube sheet. In the case of tubes not exceeding 1½ inches in diameter, they may be expanded by the prosser method in place of rolling.

I-19.—Tube-hole tolerance and use of ferrules. The initial diameter of finished tube holes shall not exceed the nominal diameter of the tubes by an amount greater than shown in the following table.

	Inches
Fire end of firetube boilers	1/32
Opposite end of firetube boilers	1/16
Watertube boilers	1/32



Fitting ferrules in tube sheets

If ferrules are used, proper allowance should be made for the thickness of ferrules. Rough and sharp edges of the tube holes shall be removed as required by the code.

Although copper ferrules are not required, they are still used extensively, especially in locomotive boilers. Copper, as is well known, has a higher range of ductility than any other metal used in mechanical lines and in tenacity it is exceeded only by the better grades of iron. In sheet form it gives a more equal distribution of contraction and expansion stresses than any other metal. Leaky flues are caused mainly by too sudden change of temperature in the firebox.

Under this condition, the copper ferrule comes into its own. While it does not entirely eliminate trouble it stands in the position of a shock absorber or as an equalizer, for then its natural properties are set in motion and a more even contraction is brought about, so that the trouble is not so great as it would be without ferrules.

It is also used as a shim when a tube hole is too large in diameter and out of round from too much expanding and rolling. It would be preferable to use copper ferrules to insure a tight fit between the tube and the tube sheet at all times. The recommended practice for applying tubes in the firebox end of locomotive type boilers is shown in Fig. 1.

The Fitting of Radial Staybolts

Q.—I have been a reader of The Boiler Maker for a great many years, and value your department highly, as I have gotten much valuable information therefrom. Now, I find myself stuck, and turn to you for enlightenment and help. This will probably give you a laugh, but I find myself with the job of renewing a crown sheet, and after 16 years of practical boiler work, including fitting-up, rolling, flanging, flue work and welding, I have never applied a set of radial staybolts, and find I have neither the taps nor the experience to work with.

1. Now, in applying rigid crown stays, say 1⅛ inches diameter by 24 inches long, working pressure 180 pounds, is the taper head bolt or straight bolt preferable?

2. Is it the practice to preserve the continuity of the thread between the upper and lower holes, that is, are the holes both tapped at the same time with the same tap, or are they tapped individually?

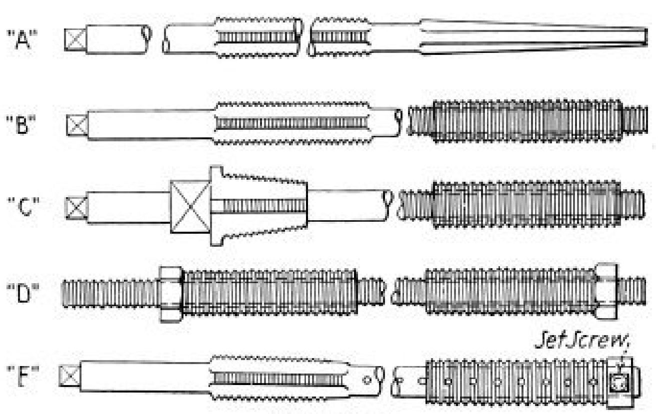
3. Please describe the taps and tapping operation in detail for both straight and taper head bolts.

4. Where can these taps be obtained?

5. In your opinion, is the application of copper ferrules in the back flue sheet desirable or necessary when the flues are to be welded to the sheet, in locomotive practice?

I would appreciate it very much if you would give this your prompt attention. J. C. H.

A.—1. The tapered crown stay is preferable to the straight bolt. Tests have demonstrated that a 1¼-inch diameter straight hammered-head crown bolt will support the crown sheet when overheated, under approximately the same conditions as the 1⅛-inch diameter hammered-head crown bolt with a 1½-inch or 2-inch taper in 12 inches. Generally speaking, it can be said that increased diameter of crown bolt at crown-sheet fit gives approximately the same holding power in a heated sheet as in-



Staybolt taps

creased taper on crown bolt, or a 1⅛-inch crown bolt with a tapered end is as good as a 1¼-inch bolt with a straight end when considering the holding power of the two stays.

Some of the advantages of the taper bolt are as follows: the bolt with a taper can be applied more economically, the bolt with a taper tightens in the sheet more readily and is not as easily stripped, savings can be effected by using one tap and reamer for several sizes of bolts, thereby reducing tool expense.

2. If the crown bolts are threaded on a turret lathe, both ends being threaded at the same time, it is better to use a continuous thread tap. If each end of the bolt is threaded separately, it will make no difference if the short tap is used, as the threads on one end may not line up in respect to those on the other.

3. When tapping holes in new roof and crown sheets, the long tap *A*, Fig. 1, is used and should be run through from the outside end with a motor, then tap, tapping first the crown sheet and then the roof sheet for straight fitted bolts.

If taper-end bolts are applied, the long tap *A*, Fig. 1, should be run through in the same way and followed up with the use of a suitable tap *C*, Fig. 1, at the crown sheet end. A telescopic sleeve should be set to guide the tap with the roof-sheet hole so that all such holes may be tapped to the same size. It is essential that a controlling shoulder on the shank of the tap next to the motor be used.

When tapping holes in new crown sheets, where the old roof sheets are used, it is not necessary to run through the long tap, which is used for new construction. Good substitutes are found in those taps having telescopic sleeves, as shown in *B*, *D*, and *E*, Fig. 1.

These will tap the crown-sheet holes true to lead if correctly made and judiciously used. Suitable taps, as *B* and *D*, Fig. 1, have sleeves which are threaded internally as well as externally, to the same lead as the tap. They, therefore, connect and thread to lead and are not dependent on small set screws and centers to keep them true to lead, as is the case shown in *E*, Fig. 1.

It is absolutely necessary to give radial stays the same lead as the tap with which the holes are tapped in order to guard against the threads being out of tram, thus causing the threads on the bolts or in the holes in the plate to strip.

4. There are numerous manufacturers of staybolt taps. The most convenient to you would be the San Francisco branch of the Pratt & Whitney Company.

5. The application of copper ferrules in the back tube sheet is desirable to insure the tightest possible fit between the tube sheet. Any working of the tube in the tube sheet will cause the weld around the bead to crack, which defeats its purpose, while the copper ferrule will tend to maintain a tight joint even after the weld has cracked.

Branch Pipe Development

Q.—In the March issue of Boiler Maker and Plate Fabricator, on page 66, you show a branch pipe of different diameters. I understand clearly, I think, your information on this subject as far as finding the length of lines from 7′-7 and 1′-1, both for solid and dotted triangles, but I do not clearly understand how you find the length of lines on the underside at 8″, 9″, 10″, 11″, 12″, 13″, 14″, 15″, and 16″ in your diagrams of solid and dotted lines, Fig. 102. How do you find the heights of lines as shown by my sketch, Fig. 1, at 14°, 15, 7, 16, 8°, 12°, 11°, 10° and 9°?

I also notice that you do not show 13° in this triangle. Do you take these heights from Fig. 96 or from Fig. 100 and how do you find the length of spaces from 15°-16° and 1′ on the upper end of pattern as shown. You also make note on this problem that same is to be continued but I find nothing on this problem in either April or May issues. I would appreciate any information on this subject, thanking you in advance for same.—C. F. B.

A.—The altitudes of the right angle triangles for the solid lines and dotted lines from 7-7′ to 1-1′ of the pattern, Fig. 103, are taken from Fig. 100 and represent the vertical distances between the corresponding points in Fig. 100, measured parallel to the line *X-Y*, as stated in the text.

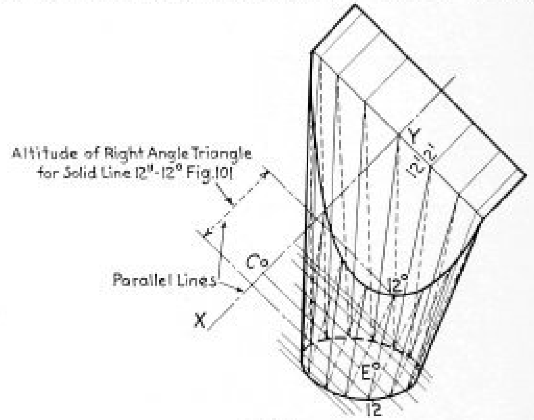


Fig. 1

Taking, for instance, the solid line 12-12°, Fig 100, the altitude is obtained as illustrated in Fig. 2.

In the same manner, all the altitudes for the right angle triangles are obtained.

The length of the spaces 15°-16° and 16°-1 in the pattern is obtained from the plan view, Fig. 97, where they are shown in their true length, as stated in the text.

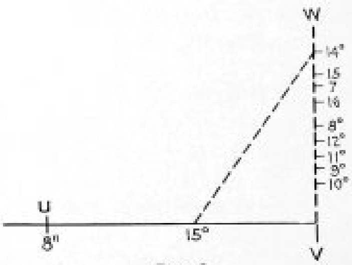


Fig. 2

In the text, it states under "Development of Pattern," "Continue in this manner, taking the short arc distances 2-3, 3-4, to 15-16 from the profile, Fig. 98, and the long arc distances 2′-3, to 6′-7′ and 15′-16′, 16′-7′ from the plan view, Fig. 97." The last distance stated should have been 16′-1′ instead of 16′-7′, and it was this error that perhaps confused you.

The development of the branch pipe is complete in the March issue. I trust that this explanation will assist you in completing the development.

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Delaware	New York	Washington
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Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

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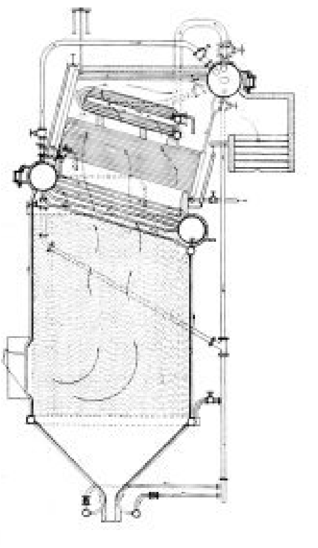
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,889,072. STEAM GENERATOR. HOWARD J. KERR, OF WESTFIELD, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

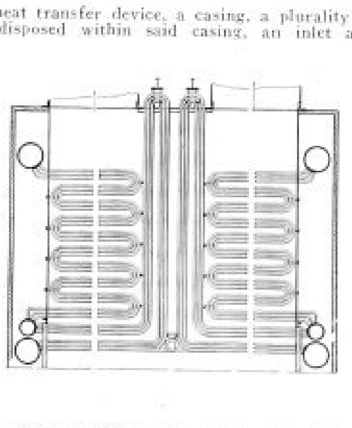
Claim.—In a steam generator, a furnace, a boiler having furnace wall tubes and having tubes extending across the upper portion of said



furnace, a boiler above said furnace, and means to establish communication between said first named boiler and the water space only of said last named boiler during the starting up period and to establish communication between the steam spaces only of said boilers during normal operation. Seven claims.

1,894,692. TUBE SUPPORT. HOWARD J. KERR, OF WESTFIELD, AND CHARLES U. SAVOYE, OF HACKENSACK, NEW JERSEY, ASSIGNORS TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

Claim.—In a heat transfer device, a casing, a plurality of tubes formed into loops and disposed within said casing, an inlet and an auxiliary



outlet header to which the inlet and outlet ends of the tubes are connected, and a second group of tubes connected to the auxiliary outlet header and extending parallel to the first named tubes for a portion of their length and at right angles thereto in a loop extending to the top of the casing, with a support for said last named tubes at the top of the casing, alternate loops of said first named tubes being supported on the right angle section of said last named tubes. Thirteen claims.

STATEMENT of the ownership, management, circulation, etc., required by the Acts of Congress of August 24, 1912, and March 3, 1933, of *Boiler Maker and Plate Fabricator*, published monthly at Philadelphia, Pa., for October 1, 1936.

State of New York, N. Y. }
County of New York, N. Y. } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared H. H. Brown, who, having been duly sworn according to law, deposes and says that he is the Editor of the *Boiler Maker and Plate Fabricator* and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Simmons-Boardman Publishing Company, 30 Church Street, New York, N. Y.

Editor, H. H. Brown, 30 Church Street, New York, N. Y.

Managing Editor, L. S. Blodgett, 30 Church Street, New York, N. Y.

Business Managers, None.

2. That the owners are: Simmons-Boardman Publishing Company, 30 Church Street, New York, N. Y.; Simmons-Boardman Publishing Corporation, 30 Church Street, New York, N. Y.; Stockholders of 1 per cent or more of the total amount of stock are: I. R. Simmons, 15 Hillcrest Dr., Pelham Manor, N. Y.; P. A. Lee, Hopatcong, N. J.; Henry Lee, Hopatcong, N. J.; E. G. Wright, 398 N. Walnut Street, E. Orange, N. J.; S. O. Dunn, 105 West Adams Street, Chicago, Ill.; C. E. Dunn, 3500 Sheridan Blvd., Chicago, Ill.; L. B. Sherman, 375 Sheridan Road, Winnetka, Ill.; Mae E. Howson, 105 West Adams Street, Chicago, Ill.; Spencer, Trask & Company, 25 Broad Street, New York, N. Y. General partners of Spencer, Trask & Company are: E. M. Bulkley, Acosta Nichols, Cecil Barret, C. Everett Bacon, William R. Basset, F. Malbone Blodget, Henry S. Allen, Henry M. Minton, William Kurt Beckers, Arthur H. Gilbert, all of 25 Broad Street, New York, N. Y. Percival Gilbert, William E. Stanwood, both of 50 Congress Street, Boston, Mass., are General Partners; Henry A. Colgate, 25 Broad Street, New York, N. Y., Special Partner, and S. Bayard Colgate, Special Partner, 15 Exchange Place, Jersey City, N. J.

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H. H. BROWN.

Sworn to and subscribed before me this 1st day of October, 1936. H. D. NELSON.

[Seal] (My commission expires March 30, 1937.)

Boiler Maker and Plate Fabricator

Newcomers in Boiler Field

The steam generating plants, the Besler automatic boiler and the Steamotive, which are featured in two articles in this issue, open up a relatively new field for the utilization of the talents of the boiler maker. The trade in this country should be given due credit for its part in what appear to be the first conspicuous and practical applications of any great success made of the high-pressure quick-steaming boiler or generator of this type.

It cannot be said that the basic ideas behind both types of steam generating plants are new or novel as both are refined developments of the flash boiler. However, the return of steam power to fields which heretofore appeared to be the exclusive property of Diesel power is definitely an event of considerable interest.

The Besler boiler is an importation from Germany where the idea has been thoroughly tested. It appears to have many qualifications to recommend it for application to existing equipment and to new trains.

The Steamotive is a native development and is a slightly less ambitious undertaking as regards evaporation rates, etc., than the Besler. The two types are similar, however, in their marked departure from the more or less established practice and introduce other ideas into the field of steam boiler manufacture.

Condition of the Industry

While accurate statistics concerning employment in the various branches of the heavy plate industry are not available, it is probably true that not since 1928 or 1929 has a year closed with better prospects for the coming one from the standpoint of steady and remunerative work.

There is nothing forced or artificial about the term in this connection, however, since it is only the natural result of a long period of curtailment in the demand for new power. The point has been reached where it is essential that the replacement program in every branch of the railroad industry be carried on at an accelerated pace. This condition extends throughout the entire maintenance and repair branches of the industry.

In these columns last month attention of the supply trade, engaged in producing materials and auxiliary equipment, was directed to the possibility of using the facilities of this publication to better advantage in presenting details of their products to the industry. By doing so a worthwhile service may be rendered to those whose duty it is to specify, select and eventually to apply such materials and equipment. Actually, a far broader field may be reached through this medium than the locomotive industry alone.

Production and, consequently, employment in the power boiler manufacturing industry, and that of heavy plate fabricating, have advanced and are still going forward to meet the accelerated demands in these fields. During the past year these industries have enjoyed a level of business not equaled at any time in six years.

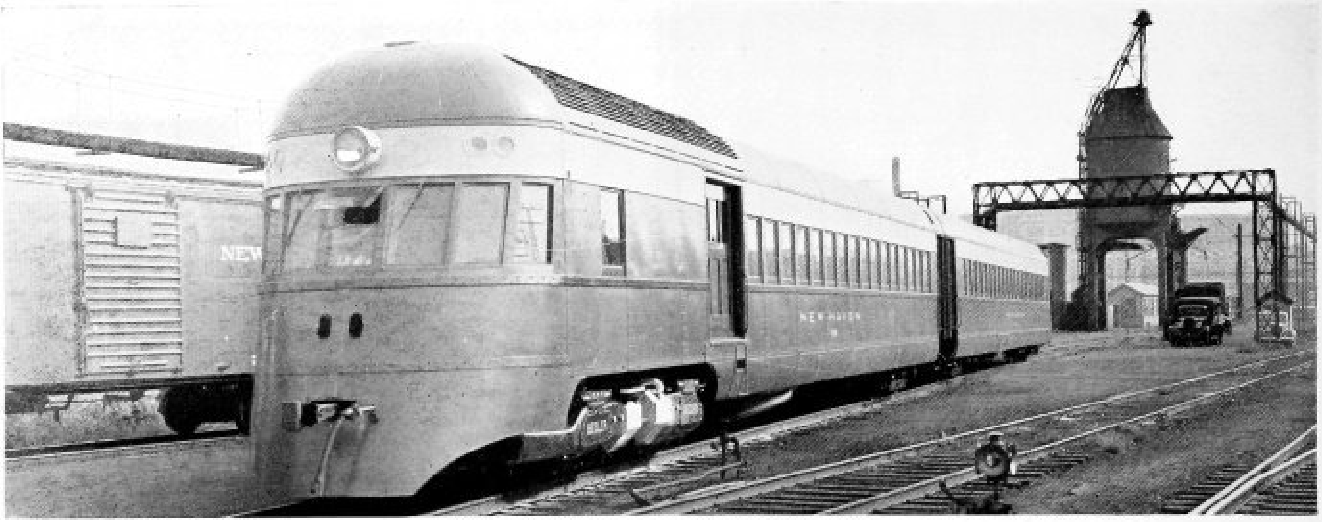
November Record Month for Locomotive Orders

In the November issue of BOILER MAKER AND PLATE FABRICATOR, comment was made on the encouraging indications of business recovery in the locomotive manufacturing industry as shown by the relatively large number of steam locomotives ordered in the first ten months of 1936. This amounted to 143 units and before going to press, the report of an order for 20 by the Union Pacific in the first week of November was also published, making a grand total of 163 for the year up to that time.

In November, in addition to the Union Pacific transaction, already mentioned, the New York Central Railroad placed an outstanding order for 100 steam locomotives, contracts being made with the American Locomotive Company and the Lima Locomotive Company for 50 each. The Chicago, Milwaukee, St. Paul & Pacific ordered 30 locomotives from Baldwin and one from American Locomotive. The Chicago, Burlington & Quincy began the construction of 11 units in its own shops. This brought the total number of new steam locomotives contracted for or ordered in the month of November to 162, which exceeds the total for the first ten months by 19.

From the first of December to the time of writing, 65 more locomotives have been ordered by American railroads. The Norfolk & Western is beginning in its shops the construction of 8 additional units of the 1200-class articulated type described in the September issue, the Seaboard Air Line has ordered 5 from Baldwin and the Denver & Rio Grand Western has also placed an order for 15 with this company. The Wheeling & Lake Erie ordered 10 locomotives from the American Locomotive Company and the Atchison, Topeka & Santa Fe placed an order for 27 with the Baldwin Locomotive Works.

This surge of locomotive purchasing has not been unanticipated as the pressing need for locomotive replacement has been well known to all followers of railway affairs. It is known that the locomotive builders have been preparing for the increased volume of business by rebuilding and reinforcing as much as possible the staffs and departments that were carried through the depression. It is feared, however, that the locomotive industry like other heavy industries which have suffered severe curtailment of activity will be hard put to obtain the vitally necessary experienced workmen and foremen for efficient production and considerable training will have to be given new employes in order to bring the industry up to its former efficiency.



The Besler two-car steam train on the New Haven

New Haven steam rail train features

BESLER AUTOMATIC BOILER

The New York, New Haven & Hartford now has in service, between Bridgeport, Conn., and Hartford, a two-car steam-powered rail train equipped with the Besler steam power plant. This train is operated in almost continuous service from 6:00 a.m. to 10:20 p.m. making six trips of 31.9 miles between Bridgeport and Waterbury and one round trip of 125.86 miles between Bridgeport and Hartford each day, giving a total daily mileage of 317.26.

When it was first decided by the New Haven to use a Besler power plant the idea was to make the most economical possible application, from the standpoint of initial investment, in order to be able to demonstrate in service the capabilities and reliability of the equipment. This would involve simply the application, to two existing coaches, of the power truck, boiler, condensers and control equipment, together with the operating compartments at the ends of the train. A preliminary consideration of this idea, however, indicated that a much better job could be done by a complete rebuilding and remodeling of the two coaches at a comparatively small increase in cost.

As finally completed, loaded with fuel and water ready to run, the weight of the train is 303,600 pounds. The two steel coaches which were converted into this train had a weight of 258,400 pounds. The application of the Besler power plant and the modernizing of the two cars, plus fuel and water and air conditioning equipment, therefore has only added 45,200 pounds to the weight of the original equipment. With 500 horsepower available at the rail the Besler train, ready to run, has a horsepower-weight ratio of 607 pounds (3.3 horsepower per ton). By comparison the New Haven Comet, loaded with fuel and water ready to run, weighs 260,590 pounds. This is powered with two 400-horsepower Diesel engines, giving a total of 800 horsepower. If, however, all auxiliary equipment is in operation at once, considering the efficiency of the electric drive, a maximum of 600 horsepower is available at the rail. This gives a horsepower-weight ratio of 434 pounds (4.6 horsepower per ton). If, instead of applying the Besler power plant in the older steel coaches as was done in this case, such a power plant were applied to two of the modern New Haven light-weight streamline coaches, it is reasonable to expect that a two-car train could be built with a total weight, ready to run, of approximately 250,000 pounds. This would have a horsepower-weight ratio of 500 pounds (4 horsepower per ton).

Two old New Haven steel coaches, approximately 20 years old, were selected and designs worked out for remodeling them by the application of the Besler power plant and other modifications into a modern appearing streamline train. These old cars were of the monitor-room construction, with narrow letter boards. As remodeled the exterior was changed to give an outside

Note:—This article is based on papers presented before the New York Railroad Club, October 16, 1936, by K. Cartwright, N. Y., N. H. & H. (describing the train), and George D. and William J. Besler (describing the power plant), supplemented by additional details concerning the boiler. There is also included a summary of questions raised during the discussion following the presentation of the two papers.

Characteristics of Besler Train and The Comet

	Besler train	The Comet
Total horsepower	600	800
Horsepower at rail	550	590 (min.)
Seating capacity	152	160
Baggage capacity	12 ft.—3,000 lb.	None
Overall length, ft. and in.	163—2½	207—0
Total weight, ready to run, lb.	306,600	260,590
Distributed weight, power truck, lb.	104,000	86,835
Trailer truck power car, lb.	67,000	43,890
Trailer, inside truck, lb.	65,000	44,375
Trailer, leading truck, lb.	67,600	85,490
Weight light train, lb.	296,100	248,590
Weight power plant and control, lb.	32,700 (approx.)	71,039

appearance somewhat comparable to the road's latest streamline coaches. The cars were stripped down, lower-deck roof sheets and some details of the old deck framing removed to save weight, and new carlines and roof sheets applied from side plate to upper deck sheets to form a turtleback roof.

On the power car a section 8 feet long at one end was reserved for application of the Besler boiler plant and auxiliary equipment. The entire length of 20 feet over the boiler room and baggage room on the roof is taken up by the condensers and exhaust steam-driven fans. A number of special details of construction had to be worked out properly to carry the weight of condensers and fans and also maintain the necessary strength across the sides of the car. The necessary control apparatus was applied in each compartment and the train is operated in either direction without turning.

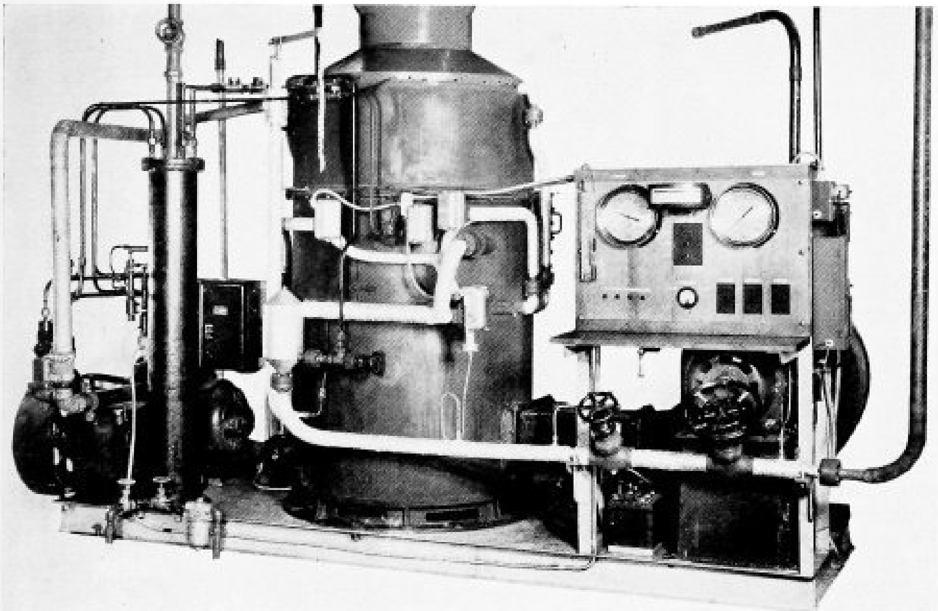
The old truck under the boiler end of the power car was replaced by the Besler power truck, all other trucks remaining the same. Fuel and water tanks of 500 gallons capacity each were applied to the power car. The cars were semi-permanently connected together, the old couplers and draft gears being retained.

The overall length of the power truck is 17 feet 8 inches, and the total width over the cylinder lagging cover is 9 feet 5 inches. The wheelbase is 11 feet 6 inches and Bethlehem low-carbon molybdenum wheels with chrome vanadium axles are used.

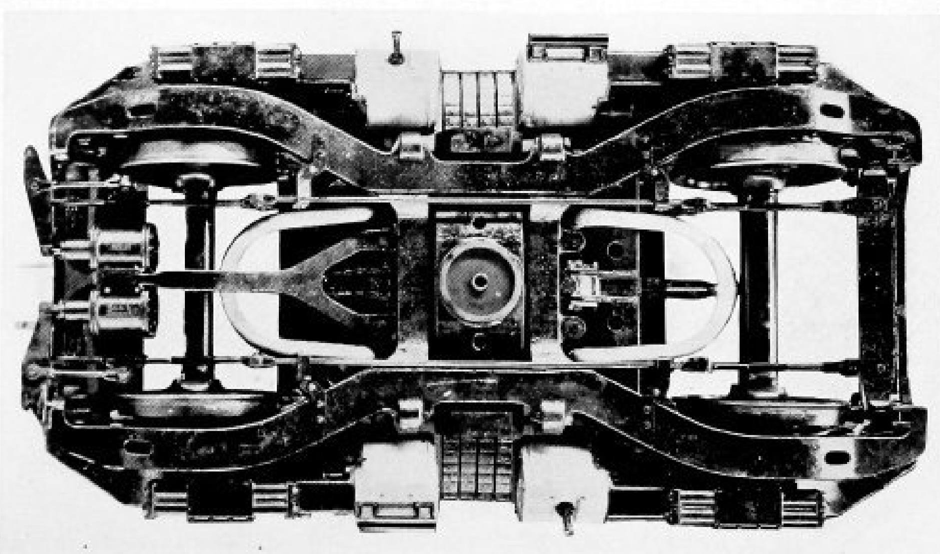
The total weight of the power truck is 35,000 pounds.

There are two direct, two-cylinder compound engines, each having cranks pressed onto extensions of the axle stub outside of the journal bearings. The high-pressure cylinder is 6½ inches in diameter and the low-pressure cylinder is 11 inches in diameter. Both cylinders have 9-inch stroke. These are conventional double-acting compound engines, with piston valves. The crossheads are cylindrical in shape and are made of cast steel with babbitted shoes. All bearings are of the roller type throughout and all working parts are machined all over.

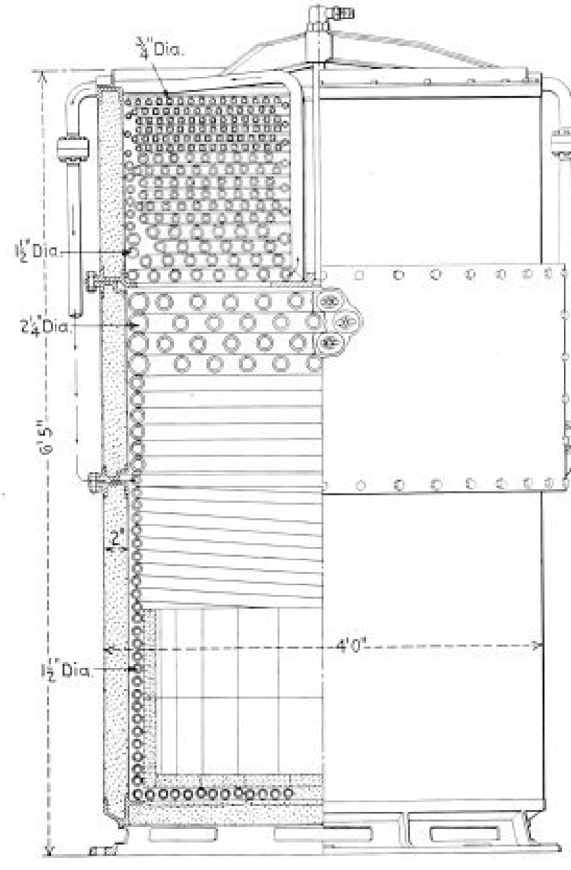
The valve mechanism is a Stephenson link motion arranged to be operated pneumatically to give two positions forward and two positions reversed. The lubrica-



Steam generator as set up in the laboratory for testing showing compactness of the Besler unit for railroad service



Top view of the power truck showing the truck and engine-frame castings as well as the brake and spring arrangement



Half section of the Besler Uniflow boiler

tion is accomplished by splash within a sealed crankcase, and a circulating plunger pump is furnished to assure lubrication at slow speeds. The cylinder relief valves are air operated.

The engine is designed for a steam pressure of 1500 pounds per square inch and, at 1200 pound inlet pressure, the truck has an average starting tractive force of 15,000 pounds. The truck is rated at 1000 horsepower, although it is capable of producing more than this with sufficient boiler capacity.

The boiler is of the continuous-flow, non-water level type, having no drums or headers. The general arrangement of the coils in the boiler is shown in an accompanying drawing. The tubes in the coils, vary in diameter from 3/4 inch in the top rows to 2 1/4 inches diameter, in the superheater section. The water enters the top of the boiler, passing down through the pancake coils where it is heated in the coils in the top six-coil sections. In the next lower six-coil sections the water is gradually changed to steam. Having reached a point in the boiler directly above the superheater coils, the saturated steam passes through a tube, indicated by the arrows in the drawing, to the outside of the boiler through which it is taken to the top of the coil group which entirely surrounds the side walls and bottom of the combustion chamber. The steam in working its way through these coils passes down alternate rows to the bottom coil underneath the combustion chamber. Having completed a circuit in the bottom coil, it passes up other alternate rows of tubes to a point at the top of the combustion chamber where it enters the bottom of a seven-tube coil immediately under the superheater section. After passing through this section it goes into the superheater section composed of five rows of header type coils. The superheater coils are U-shaped in arrangement with the return bends at one end and a cross-header between coil units at the opposite end at which clean-out hand-hole plates are fitted to the boiler shell. The formation of scale in this type boiler is confined to the superheater section and the clean-out hand-holes are provided to facilitate the use of a mechanical cleaner in the superheater tubes. The entire boiler is encased in an airtight sheet-steel housing with 2 inches of insulation between the inner and outer casings. The inner casing is constructed of corrosion-resisting Inconel and the outer casing, separated from the inner casing by insulating brick, is made of sheet iron.

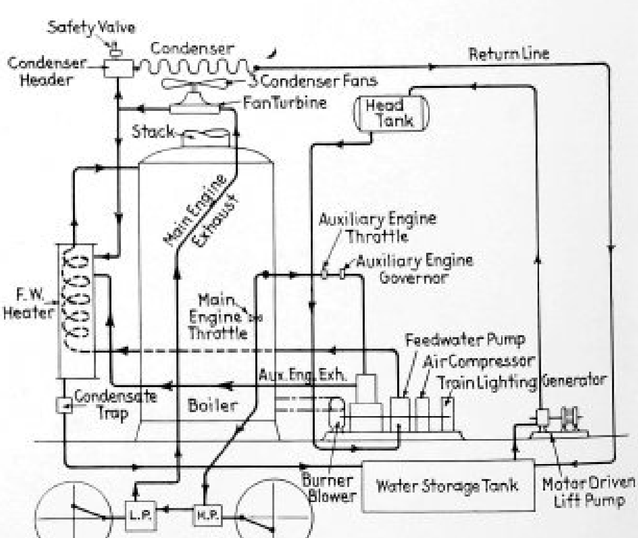
The boiler is equipped with fully automatic safety devices to protect it against empty water tanks or other contingencies.

The burner is the pressure atomizing type of Besler design and construction. It automatically meters the fuel in proportion to the flow of air which is delivered by a multivane type blower. Adjustment is not necessary because of a change of altitude or a change in draft pressure, and the burner automatically compensates for changes in air flow caused by entering tunnels, high speeds, or cross winds—in every case metering the correct amount of fuel. The burner operates fully on or off. Ignition is secured by a high-tension electric spark.

The auxiliaries are driven by a two-cylinder, 90-degree V-type double-acting steam engine. The water pump drives are integral with the main crank shaft. The auxiliary steam engine drives the electric generator through V-belts. The generator supplies current for lighting, ventilating and for the requirements of the power plant. The auxiliary engine also drives the air compressor and the forced-feed main-engine lubricators. It operates at a back pressure and exhausts into the train-heating line. When train-heating is employed the power used to drive the auxiliaries represents only two percent of the boiler output.

The condensers are of the fin and tube type, placed on the roof of the car. Propellor type fans driven by individual exhaust-steam turbines of our own design and manufacture are located adjacent to the condenser cores on the roof and draw air through the cores, discharging it upward.

The turbine speed inherently varies in proportion to the steam flow, producing the optimum relation between air flow and condenser load at all outputs.



Schematic diagram showing the relation and functioning of the various parts of the equipment

General Scheme of Operation

Reference to the accompanying schematic diagram will help clarify the functioning of the various units involved in the power plant and auxiliary. Water from the main storage tank is pumped by a motor-driven lift pump to a header tank, thence to the boiler feedwater pump which is one of the three auxiliary units driven by a high-pressure auxiliary engine. From the feedwater pump the water passes through the feedwater heater, thence to the boiler. Its course through the boiler has been previously described. Superheated steam at constant temperature and at a maximum pressure of 1500 pounds per square inch leaves the main steam outlet of the boiler. Superheated steam is used in the main engines on the power truck and in the auxiliary engine. The main engine exhaust is piped to the three condenser fan turbines. The auxiliary engine exhaust is piped to the feedwater heater. Exhaust steam after passing through the feedwater heater and the fan turbines goes to the condenser header which is equipped with a safety valve as a protection against excess pressure in the condenser coils. The condensate from the condenser passes through a return line to the water storage tank.

Questions and Answers Concerning Operation

At the New York Railroad Club meeting at which the description of this train was presented many questions were asked concerning this equipment. The answers to a number of these questions as given by W. J. Besler, are included herewith.

1. Q.—*What is the percentage of makeup water in the summer time when steam is not used for heating?* A.—It is approximately the same as in the winter when water is lost through heating. In the winter time, there is no return from the heating pipes, so that the water is wasted. No records of the amount of water consumed by the power plant are available at present.

2. Q.—*How is scale formation prevented in the boiler?* A.—Scale is not prevented. Scale forms only in a certain portion of the boiler which is provided with clean-out openings. Cleaning is accomplished either by dissolving it, or by the use of a turbine cleaner after removing the clean-out plugs, which is a simple operation. Any other means of feedwater treatment may be used to keep down the scale deposits.

3. Q.—*Is the steam superheated?* A.—Yes, the steam is superheated. At 500-pound pressure or 800-pound pressure, the temperature is maintained constant at the outlet of the boiler and runs 760 degrees. It is maintained at that point to give a good overall efficiency and good lubrication.

4. Q.—*How does oil treat the feedwater?* A.—Oil goes into the feedwater because the engines are lubricated by spraying oil into the engine cylinders. The oil is carried to the condensers and from there it is returned to the feedwater tank. This oily feedwater is pumped to the boiler, which is one of its features. In a steam automobile boiler, which is now 27 years old, the boiler has never been touched. The tubes are perfectly clean because of the presence of a large percentage of oil. Upon analysis this was found to be some four or five percent of the feedwater.

5. Q.—*Is straight mineral oil or compounded oil used?* A.—Both types of oil are used.

6. Q.—*Does the atomizing burner run intermittently or at varying speeds, so as to develop steam in proportion to the speed requirements of the train?* A.—The atomizing burner is of the on-and-off type.

7. Q.—*How is feedwater regulated?* A.—There is a control mechanism which supplies water whenever the pressure is sufficiently low and whenever the temperature is right. The injection of water is proportioned according to the temperature within the boiler. It is fully automatic in operation.

8. Q.—*What kind of fuel is used?* A.—So far, any type of fuel has been used with which we have come in contact. On this train the lighter grade of fuel is preferred, as the cost is not yet prohibitory. Any of the oils produced in America can be burned, as they have been tried in the laboratory.

9. Q.—*What is the combustion rate in the boiler?* A.—Over 500,000 B.t.u.'s per cubic feet per hour, although a maximum of over 2,000,000 B.t.u.'s per cubic feet per hour have been released.

10. Q.—*What is the stack temperature?* A.—500 degrees F.

11. Q.—*What is the water rate of the engine at various speeds?* A.—10 pounds over a wide range of speeds and loads. That water rate can be maintained from 1200-pound inlet pressure down to 400-pound inlet pressure, which is the operating range at the present time.

12. Q.—*How frequently must scale be removed from this type of boiler?* A.—The present indications are that it should be removed each 30 days, although on the New Haven train, it was operated the first six weeks without removing scale.

13. Q.—*What is the weight of the boiler?* A.—5100 pounds complete.

14. Q.—*What effect will snow have on the condenser exhaust fan?* A.—When snow comes in contact with the fans two things may happen to dispose of it. Either the fans will throw it out of the way or the heat will melt it.

15. Q.—*What is the temperature of the boiler room?* A.—Temperatures as high as 140 degrees have been recorded in the boiler room, although at that time no one was in the room.

16. Q.—*Are conventional snap rings used on the pistons of the engines?* A.—Yes.

17. Q.—*How many rings are used on each piston?* A.—Six.

18. Q.—*What is the maximum speed of this train, and at what speed is maximum horsepower developed?* A.—The horsepower is constant from 12½ to approximately 65 miles per hour. The train is guaranteed to do 70 miles per hour, although on one run a maximum of 82 miles per hour was reached. Operating conditions necessitated limiting the speed, so that it is not possible to say how much more speed it might be possible to attain.

19. Q.—*Is a fireman used on this train?* A.—Yes, when the train is backing up, that is, being operated by means of the controls at the opposite end from the power unit, the fireman rides with the engineman, 160 feet away from the boiler.

20. Q.—*How much power is required for the condenser exhaust fans?* A.—The condenser fans require approximately 30 horsepower under a full load. That is available at a loss to the engine which is not very great, as 12-pound back pressure on the engines does not amount to much horsepower. Turbines are used for driving the fans.

21. Q.—*With moderate volume production, what proportion of the total cost of the train is in the power plant?* A.—On the New Haven train, approximately one-fourth of the cost is represented by the power plant and three-fourths for the train.

22. Q.—*Approximately how long would it take to remove the power truck and install a reserve truck in*

case of necessity? A.—If a reserve power truck were available, it would merely be a problem of lifting the car, rolling the new truck in, dropping the car and making the various steam and air connections.

23. Q.—*Is the boiler operated at constant pressure?* A.—No attempt is made to maintain constant pressure. The boiler operates at a constant superheating outlet temperature. A constant temperature is maintained, as that is what determines proper lubrication and efficiency.

24. Q.—*Is the lubricating oil atomized into the cylinders or fed onto the cylinder walls?* A.—It is fed into the valve chamber and atomized by the velocity of the steam.

25. Q.—*What is the fuel consumption per hour?* A.—One pound of fuel per horsepower hour.

26. Q.—*When the train is operated by means of the controls at the opposite end from the power unit, what controls and what gages does the operator have for feedwater for the boiler?* A.—The controls consist of a throttle, air-brake valve and reverse mechanism. There is nothing to indicate to the operator what is going on at the power plant, as the operation of the boiler is entirely automatic.

27. Q.—*What type of a transmission is used?* A.—There is no transmission. The steam engine connecting rods are directly connected to cranks which are pressed on to an extension of the axles. It is interesting to note that there is not a single gear of any description on these two cars.

28. Q.—*How is the control operated from the opposite end of the train?* A.—Pneumatically.

29. Q.—*What is the storage capacity of the boiler?* A.—Only enough to go about half a mile. Storage capacity is not carried in the boiler water, but in the hot tubes. As the pressure drops an additional quantity of water comes from the economizer section of the boiler, and in contacting the hot tubing it generates steam which gives this boiler its amazing reserve capacity.

30. Q.—*How long does it take to get the boiler hot from cold water?* A.—The rail car is able to get steam up in an average time of five minutes from dead cold. It cannot be operated in five minutes, however, because of the necessity of pumping up air for about 12 minutes. The time required from stone cold to the point where it is ready for operation depends upon the time required to pump up air. As far as the boiler is concerned, working steam pressure can be built up in approximately 3¼ to 4 minutes from the time the fire is started.

Machine-Made Jobs and Present Employment

Major industries which have instituted the greatest technological changes in the last few years have added millions of wage earners to their payrolls and many of them employ more workers today than in 1929, according to a study made by the Machinery Institute and reported recently in a pamphlet "Machine-Made Jobs."

The report is the third of a series by the Institute, of which John W. O'Leary is president, giving factual evidence that jobs are created by the advance of science and invention. The contents are "buts and ands that must be considered in connection with common statements which on the surface appear to prove that machines cause unemployment."

"Vast technological improvements have been made in the automobile industry, which have greatly increased productive capacity of workers in many jobs," says the pamphlet. "But employment per vehicle manufactured was 25 percent higher in 1935 than in 1929. And last year 109 workers had jobs making automobiles for every 100 between 1923 and 1925."

It deals with many of the leading industries in which machine developments are often accused of having destroyed employment opportunities. Among the facts presented are:

Telephone girls increased by more than 50,000 during the ten years that the dial system was being installed, and linemen increased 100 percent.

Ice dealers more than doubled between 1920 and 1930 because mechanical refrigerators popularized all refrigeration.

It takes far more workers to furnish the textile demands of a thousand Americans today than it did in the colonial days of spinning wheels, due to increased use of textile products as a result of lower prices when machine methods are used.

Machines have revolutionized office work in recent years, yet stenographers and typists increased 32 percent and bookkeepers, cashiers and accountants increased 27 percent between the last two census years. Population increased only 16 percent.

Sound pictures displaced 50 percent of all theater musicians, but during the same years musicians and teachers of music increased by 35,000, actors by 17,000, theater ushers by 7000 and radio employes by 15,000.

A printer today can set more than five times as much type as one without a linotype did in 1890, yet there are five times as many employed in the industry as there were then because machinery has lowered prices and made possible the vast growth of the printing and publishing business.

"Some of the greatest technological developments in America in recent years have taken place in the iron and steel industries," says the pamphlet.

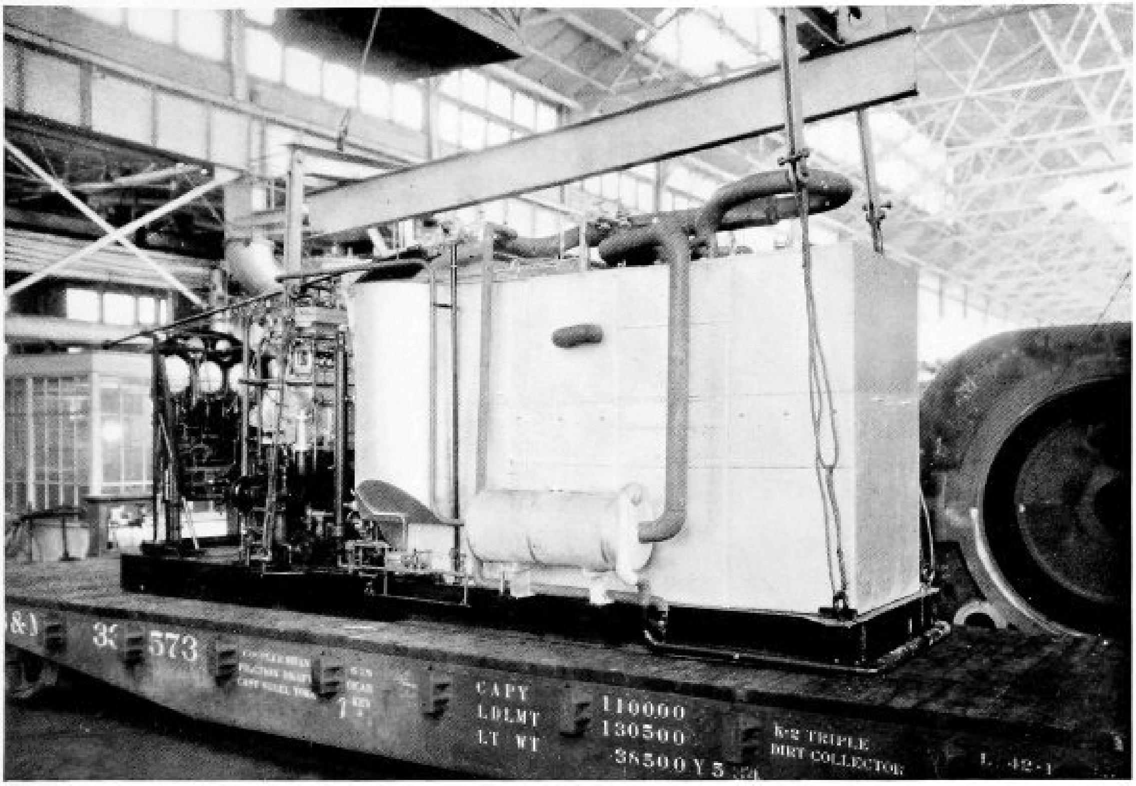
"But the use of steel in the United States increased from 2600 pounds per person in 1900 to 16,800 pounds in 1935. There used to be only two or three kinds of steel, but today there are about 10,000 different specifications as to alloys, sizes, finishes and shapes that modern industry demands.

"And employment has grown from less than 150,000 sixty years ago to about a half million today, and despite, or because of, the recent technological changes employment in 1936 passed the 1929 peak. Production is far below capacity and with its inevitable rise employment will go even higher."

The employment of both women and children in manufacturing industries has declined during the last generation while mechanization has been greatest, and the employment of men in manufacturing and mechanical industries has more than doubled since 1890, according to the Institute. Wage and salary earners get a larger percentage of the national income today than ever before, largely because machinery has increased workers' productive capacity and earning power.

Western Boiler Maker Dies

Richard J. O'Neill, former national president of the Boiler Makers' Association of America, died November 12 at his home in Denver, Colo. He was 78 years of age. Mr. O'Neill had been employed by railroads in every part of the United States. Forty years ago he built the first camel-backed locomotive in Rawlins, Wyo. He first came to Colorado in 1904 to accept a position with the Colorado & Southern Railroad. At the time of his retirement he was general foreman boiler maker for that road.



Steamotive unit on flat car ready for shipment

Steamotive—A Modern Power Unit

The design and testing of a new type of steam-generating unit of good efficiency, relatively light in weight and requiring a minimum of space, was described jointly by the General Electric, Babcock & Wilcox, and Bailey Meter companies at the annual meeting of the American Society of Mechanical Engineers, in New York City, November 30, by E. G. Bailey of the Babcock & Wilcox Company. A. R. Smith of the General Electric Company, and P. S. Dickey of the Bailey Meter Company presented the paper at the meeting.

The new type of steam-generating equipment has been named the Steamotive. In it, steam is generated at high pressure and temperature; and fully automatic control in response to changes in demand has been incorporated. The units are intended for capacities of from 2000 to 10,000 horsepower.

Two such units have already been built. The first, now in service in the Lynn, Mass., works of the General Electric Company, is used to test marine and other small turbines. It has an output of 21,000 pounds of steam per hour at a pressure of 1500 pounds per square inch.

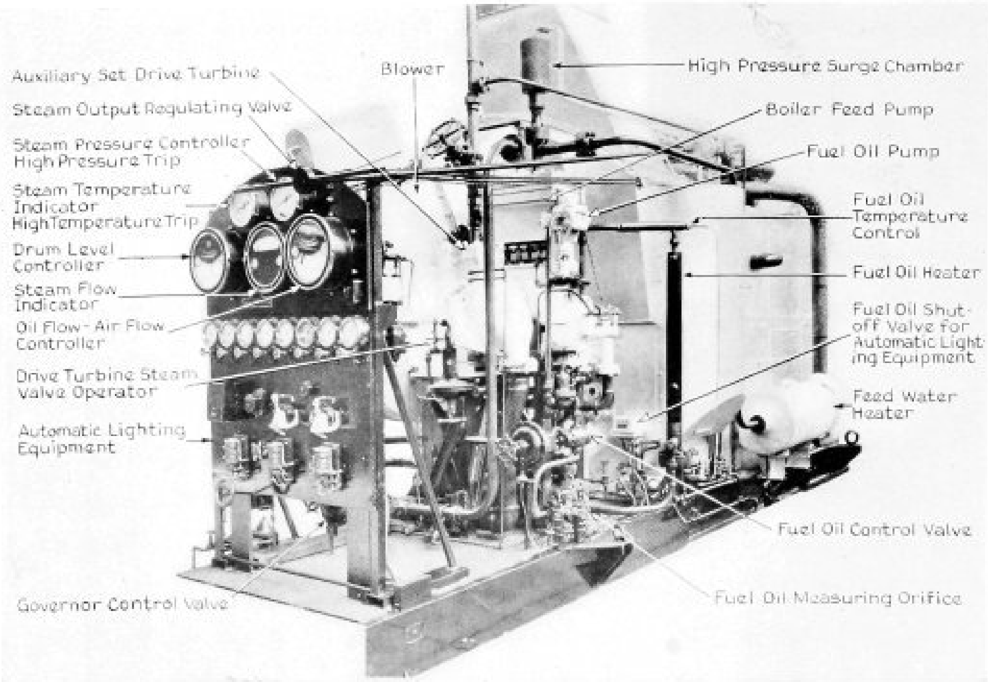
Another, a completely co-ordinated power-generating plant incorporating the Steamotive and turbine-generator, with a capacity of 10,000 pounds per hour and furnishing steam to a turbine at 1200 pounds per square inch and 950 degrees F., is being installed in a small, isolated plant of a large industrial concern to supply electric power and low-pressure steam for building heating. Both are oil-fired.

Two oil-fired Steamotive units, each with a capacity of 40,000 pounds per hour, are now being constructed for the Union Pacific Railroad for driving two 2500-horsepower electric locomotives, it was announced at the meeting. These units will furnish steam to the turbines at 1500 pounds per square inch and 950 degrees F.

Indicating the compactness of the Steamotive unit, the one for Lynn was shipped complete from Schenectady on a railroad flatcar.

Objectives sought in the design of the new equipment were pointed out by the speakers as high steam pressure and temperature, minimum weight and size per unit of steam produced, wide range of capacity with ability of the unit to respond quickly to wide variations in load conditions, adaptability to wide range of fuels, completely co-ordinated auxiliaries, completely co-ordinated automatic control, and units of simple design and constructed in sizes small enough to be portable.

Answering these specifications, the Steamotive boiler was designed and built by The Babcock & Wilcox Company at Barberton, O. The meters and complete automatic control were designed and built by Bailey Meter Company, Cleveland. The auxiliaries which supply fuel, air, and feed water are controlled in accordance



General view of generating unit now in commercial service at the Lynn, Mass., works of the General Electric Company for testing

with demands for steam. Complete automatic ignition and safety equipment are included.

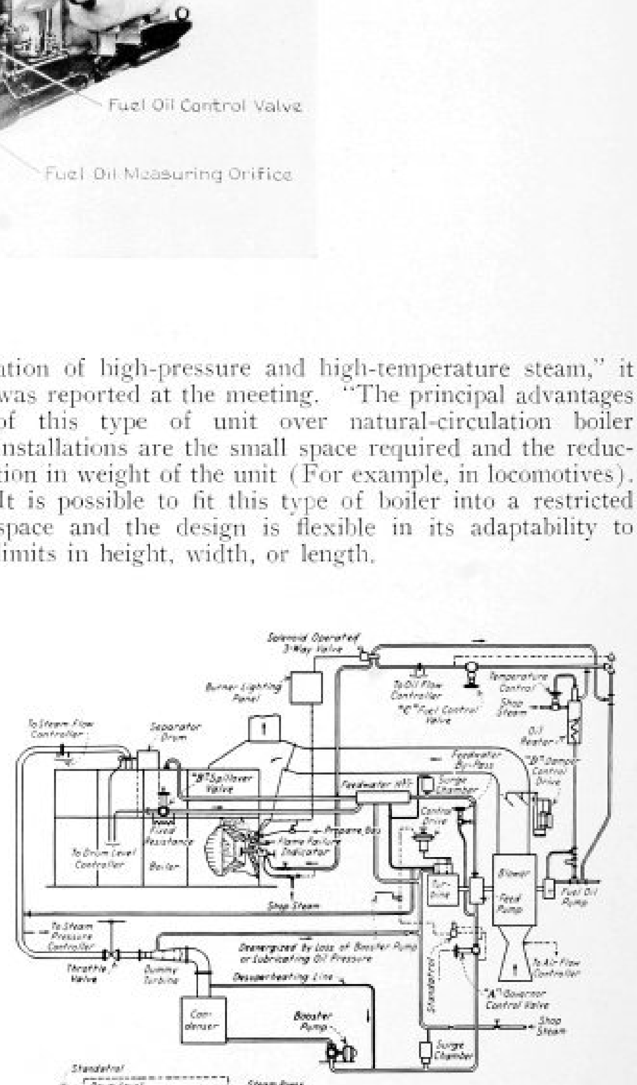
The auxiliary set was designed and built by the General Electric Company, which company also did the assembly work of the complete unit at its Schenectady plant. The auxiliaries, geared together as one turbine-driven unit, in the case of the unit at Lynn consist of a feed pump delivering 25,000 pounds of water per hour at a pressure of 2000 pounds, a blower for 30,000 pounds of air per hour at 60-inch water pressure, a fuel-oil pump, and a lubricating-oil pump. The complete Steamotive unit was designed and constructed so as to be suitable for installation in a locomotive in conjunction with turbine-electric drive installed by the General Electric Company.

In the operation of the Steamotive unit, the flame and gases pass from the burner through the completely water-cooled furnace, thence into the superheater, flowing around the separator, through the economizer and air heater, and up the stack. The air for combustion leaves the blower at relatively high pressure passing through lanes intersecting the stack, and down around the air-heater tubes to the oil burner. There is no induced draft fan, the blower forcing the air through the burner and furnace under pressure.

The feed water enters the economizer inlet header, and, after leaving the outlet header, is divided into several circuits, all of which form the floor, sides, and roof of the furnace, as well as the sets of loops forming the boiler screen. All the steam is generated in these furnace and boiler circuits, and enters the separator, with a surplus of water in each circuit. From the separator, the dry steam goes through the superheater, and directly to the main turbine. The water from the separator is called the spillover, and it passes through a heat exchanger to the hot well, where it mixes with the condensate, and is refed to the boiler by the feed pump.

Due to the compact arrangement of the Steamotive unit, it constitutes what is practically a packaged power plant.

"Tests made on the developmental Steamotive unit and subsequent design studies indicate that a steam-generating unit of this type is entirely practical for generation of high-pressure and high-temperature steam," it was reported at the meeting. "The principal advantages of this type of unit over natural-circulation boiler installations are the small space required and the reduction in weight of the unit (For example, in locomotives). It is possible to fit this type of boiler into a restricted space and the design is flexible in its adaptability to limits in height, width, or length.



Diagrammatic layout of Steamotive unit at Lynn

"The elimination of refractory in the furnace and boiler setting, replaced by waterwalls and insulating block, not only results in a large saving in weight and volume, but also in reduced heat capacity that materially affects the ability to change output quickly. The small water content of the forced circulation boiler results in quick response to load changes and insures safety in spite of the high-temperature and high-pressure steam conditions. These factors permit quick starting from a cold condition, requiring less than ten minutes from lighting the burner to full output. It has been found that combustion liberation rates up to 400,000 British thermal units per cubic foot per hour can be obtained with low excess air and smokeless combustion with oil fuel. The pressure furnace which utilizes forced draft only is entirely practicable and materially simplifies the draft equipment and control therefor.

"The wide-range burners used on this unit and the co-ordinated auxiliary set make complete automatic control a thoroughly practicable device. Completely automatic lighting of the burners has been entirely satisfactory, and the use of safety devices which automatically cut off the oil fire has proved a more effective protection than safety valves and other protective devices common on natural-circulation boilers.

"It is essential that the application of a unit of this character be carefully considered, since reduction in weight and space requirements can only be obtained through increase in auxiliary power and reduction of plant efficiency, especially at high loads. In certain applications the problem is simple, since the space requirements are definitely fixed. However, where space is available, it is generally more economical to use a larger unit, improve boiler efficiency, and reduce auxiliary power."

Marine Steam Boiler Developments

By G. P. Blackall

Signs are now evident that a new phase is beginning in marine steam generation in which far higher pressures and temperatures will be employed. The steam conditions of the *Prinsendam,* for example, the new 33,000-ton Holland-America liner, are 600 pounds pressure and 770 degrees F. temperature, and they constitute a notable advance on the conditions of 430 pounds pressure and 650 degrees temperature adopted in the *Statendam,* built for the same owners in 1929.

In dealing with the future of steam propulsion in his Thomas Lowe Gray lecture this year, John Johnson referred to a typical installation "B" of 30,000 shaft horsepower as being representative of the practice of 1930, with steam conditions of 375 pounds pressure in the high pressure receiver, say 425 pounds at the boiler stop valve, and 740 degrees F. temperature, for which an oil fuel consumption of 0.57 pound per shaft horsepower hour for propulsion was indicated. In a comparison with a hypothetical installation denoted as "C" and dated 1936, to work at 450 pounds pressure and 850 degrees temperature, Mr. Johnson stated that with these conditions a fuel consumption rate of 0.5 pound of oil per shaft horsepower hour would be maintained in service. He mentioned that the designs for the latter vessel, with machinery of 28,000 shaft horsepower, are completed. The new Hamburg-Amerika liner *Gneisenau* has turbine machinery working at 735 pounds and 878 degrees F.

In all these cases the boilers are of the drum type working with natural steam and water circulation. The *Prinsendam* is to have Yarrow boilers, but the new Canadian Pacific tonnage will presumably have the improved Johnson type of watertube boiler. The new Hamburg-Amerika liners have Wagner boilers. In these respects, therefore, the designs represent a natural evolution along lines which are now accepted as the result of satisfactory experience. With increasing boiler pressure difficulties arise in boiler drum construction because of the heavier scantling of material required, while the factor of circulation demands fuller consideration. New designs of boiler are therefore being introduced in which the drum is omitted and forced circulation adopted, with the result that a considerable increase in heat transmission rate becomes possible with substantial reduction in size and weight of boiler.

A good measure of boiler capacity is provided by the evaporation expressed in terms of pounds of steam per hour per ton weight of boiler. This figure is about 800 for high-capacity generators with natural circulation. The Benson boiler installation in the liner *Potsdam,* working at 1325 pounds pressure and 878 degrees F. temperature, has a corresponding capacity coefficient of about 1250, and an approximately similar figure applies to the Velox forced-circulation boiler with steam conditions of 450 pounds pressure and 825 degrees. A Velox boiler has recently been installed on one of the Messageries Maritimes liners.

The Rotterdam Lloyd liner *Kertosono* has recently been speeded up by replacing one of the original cylindrical boilers with a Sulzer mono-tube superpressure steam generator, working at 880 pounds per square inch and 700 degrees F., and fitting a high-pressure back-pressure turbine unit to act as a primary turbine to the existing plant. Output has been raised from 4500 horsepower to 6000 horsepower, raising the speed from 13 to 15 knots.

The future would appear to lie evenly between the high-capacity natural circulation boiler working at appreciably higher pressures than have hitherto been employed, with the advantages it offers in retention of the water and steam drums to serve as a feed reservoir for meeting emergencies, and the forced-circulation generator working at the highest pressures and temperatures practicable, with heat transmission rates substantially greater than with existing orthodox practice, which will result in very large savings in weight.

Explosions in Compressed Air Lines

Fatalities occurred in two metal plants recently when air line accidents occurred in rooms where employes were working.

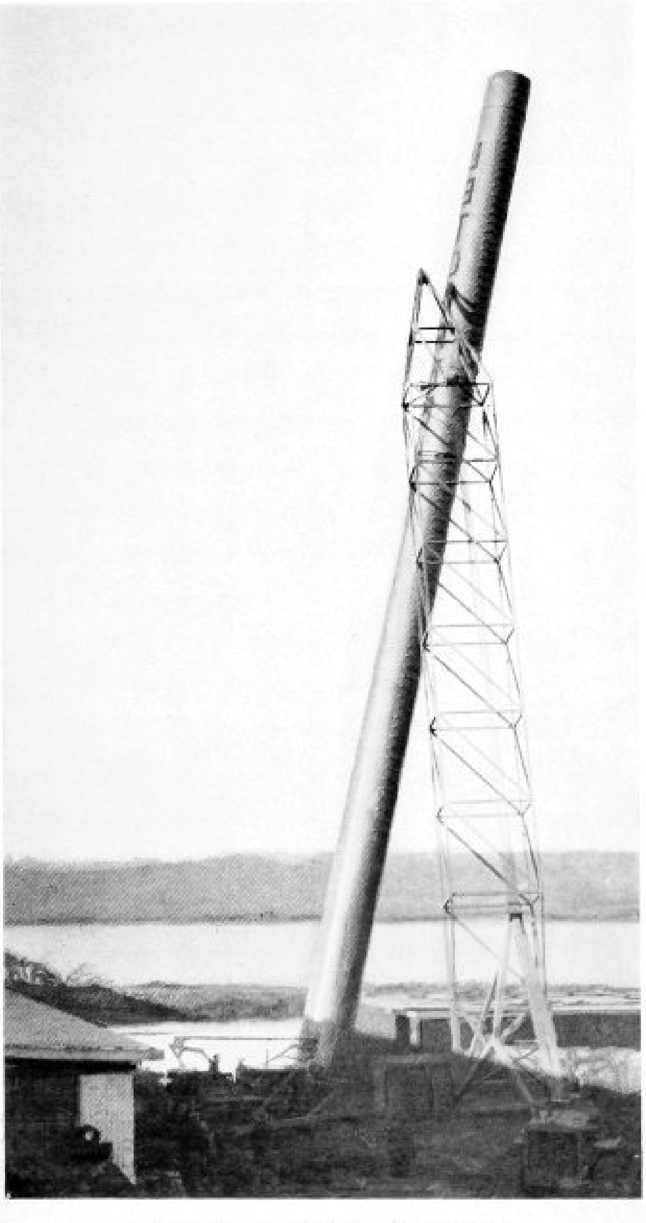
One of the failures was attributed to a combustion explosion in a high-pressure 2-inch diameter line carrying air at 500 pounds pressure for use in die casting machines, the pipe failing at several points. A 2-inch forged steel elbow was split cleanly, and two safety valves were shattered. The operator of one die casting machine was killed and there was considerable damage to piping, valves, fittings, equipment and walls adjacent to the exploded lines. While the cause of the accident could not be definitely determined, it is believed reasonable that some of the lubricating oil from the compressor was carried over into the system and ignited, probably at one of the die casting machines where the air was in contact with molten metal. The compressor supplying the system was equipped with both an intercooler and an aftercooler and the piping was tested at intervals in the interest of safety. After the accident double extra heavy pipe of $\frac{7}{16}$ inch thickness was installed, and to minimize the possibility of a similar occurrence an oil separator was placed between the after cooler and the receiver. It also was advised that oil being fed to the compressor be kept at an absolute minimum.

The other accident occurred to piping used in connection with air hammers at a Pennsylvania steel mill. When the air line broke, an air receiver toppled over on a workman with fatal results.—*The Locomotive*.

All-welded Smoke Stack Erected

In building a plant to heat its factory at Peoria, Ill., R. G. Le Tourneau, Inc., manufacturers of heavy grading equipment, were confronted with the problem of constructing and erecting a smokestack tall enough to carry the smoke clear.

Inside the plant, ¼-inch plate was pre-fabricated into an all-welded stack 104 feet high, 57 inches in diameter



Hoisting all-welded stack into position

and weighing approximately 10 tons. This is thought to be the tallest pre-fabricated steel stack ever erected. The stack is anchored to the floor and roof of the boiler house, which reduces its outside height to 83 feet. A portable tractor-powered crane of all-welded design was built to lift and place this stack and for other heavy duty.

To erect this stack, a feat which was performed in 30 minutes, the crane was equipped with an 84-foot boom. It is reversible, however, the boom becoming a tongue and the 22-foot tongue a boom, which gives it a 40-ton capacity.

Income Derived from Manufacturing

Manufacturing is the largest industrial source of the national income, generally contributing 20 percent to 25 percent of the total, according to a study just published by the National Industrial Conference Board. In 1935, the board estimates receipts from manufacturing in salaries, wages, dividends, interest, and other payments at $12 billion.

The Conference Board's study makes available for the first time estimates of income from manufacturing in each of the individual states. Other studies will be ready shortly giving income by states.

Income from manufacturing was a little over $18 billion in 1929, but dropped rapidly with the advent of the depression and in 1932 and 1933 was less than $8.5 billion. From this low point it has risen steadily. Preliminary indications are that a substantial gain will be recorded for 1936.

Approximately three-fourths of the total income from manufacturing, the Conference Board points out, is received in the northeastern section of the United States. Of the total estimated income for 1935, the Middle Atlantic states received 34 percent, the East North Central states 30 percent, and the New England states 11.5 percent. New York alone received $2,014 million, or 17 percent of the total. Pennsylvania, the second largest manufacturing state, received an estimated $1,352 million, or nearly 12 percent of the total.

Salaries and wages are by far the largest single type of income contributed by manufacturing industry and account for 80 percent to 85 percent of the total. Dividends, the second largest type of payment, account for 12 percent to 15 percent of the total. The remaining 4 percent or 5 percent of income from manufacturing is made up of entrepreneurial income, interest, and net rent.

New Line of Electrodes Announced

Metal & Thermit Corporation, 120 Broadway, New York, announces an addition to its line of Murex heavy coated electrodes for arc-welding.

The new electrode, known as Murex Type N, is designed for bridging gaps where fit-up between plates is poor and, in the smaller sizes, may be used on vertical and overhead work, or to make rapid, single pass welds on light-gage materials. The physical properties of the metal deposited by this electrode are said to range from 74,000 to 84,000 pounds per square inch in tensile strength, with 26 percent to 24 percent ductility. The new electrode is also said to work equally well with either direct current or alternating current and may be used either with straight or reversed polarity.

Application of code rules to

Vessels Under External Pressure*

By W. D. Halsey**

The action of a vessel under external pressure is different, in many respects, from its action under internal pressure. A vessel under internal pressure, is, for the most part, under tensile stress and it tends to change to a shape of greater strength. That is to say, a cylindrical vessel under internal pressure tends to take the shape of a sphere and would do so if the material were sufficiently ductile. On the other hand, a vessel under external pressure tends to change to a weaker shape. As the change in shape occurs, its resistance to such change is very much reduced and failure takes place rapidly at a pressure even less than the vessel could safely withstand in its original form.

The action of vessels under either internal or external pressure may be compared to the action of test specimens of steel under tensile stress or under compression. The material in the shell of a vessel under internal pressure acts in the same manner as a specimen under tension. A vessel under external pressure acts in a manner quite similar to a specimen under compression. This comparison of the effect of external pressure may be carried a little further by considering the action of long and short specimens under compression. Specimens in which the thickness or diameter is small as compared with the length will, under compression, tend to bend easily. Some bending may take place before the stresses reach the yield point or elastic limit of the material. If, when a certain amount of deflection has occurred, and before the yield point of the material is reached, the load is removed, the specimen will return or spring back to its original condition.

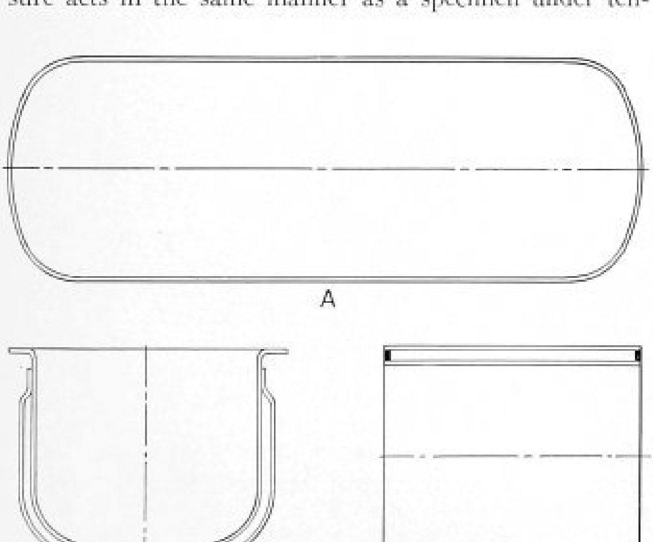


Fig. 1

However, when the specimen bends, it immediately loses strength, it very soon passes the yield point and, because of the change in shape, the continued application of the load will cause it to fail. Specimens which have a large thickness or diameter as compared to their length will not bend under a compressive load but will upset or change shape by increasing in diameter or cross section.

A specimen in which the thickness or diameter is small as compared with the length is said to fail by "instability." On the other hand, a specimen that has a large diameter as compared with the length is said to fail by "yielding." Pressure vessels under external pressure may fail in either of these ways.

The *ratio* of plate *thickness* to diameter and also the ratio of the length of cylinder to diameter are very important in the analysis of vessels subject to external pressure and will be extensively used in this discussion.

Vessels with walls that are relatively thin as compared to the shell diameter change shape readily under external pressure and, by such action, become weaker and deflect still further from the original shape. However, until actual permanent change in shape takes place the stresses in the material do not reach the yield point. Such vessels are said to fail by instability. Other vessels which have walls that are relatively thick as compared with the shell diameter do not fail until the stresses in the material reach the yield point. They then start to deflect and thus become progressively weaker. The yield strength of a short thick column is easy to calculate, it being simply a matter of dividing the load by the cross sectional area of the specimen. It is also easy to calculate the strength of a vessel that will fail by yielding, as the computation is the same as that used for vessels under internal pressure. However, just as the strength of a slender column depends upon its length and its cross-sectional dimensions, so also does the strength of a vessel, that has a thickness small in comparison with its diameter, depend upon its length, thickness, diameter, and, of course, upon the physical properties of the material.

In a cylindrical vessel under external pressure, the heads, by maintaining the circular shape of the vessel at its ends, tend also to strengthen the entire structure. Therefore, the distance between the heads, or supporting rings, of a vessel enters into the determination of its strength. On the other hand, when the length of a vessel reaches a certain point the heads no longer help support the middle portion, so that the collapsing pressure remains unchanged for any further increase in length.

The calculation of vessels under external pressure involves some very complex mathematics. The new rules for external pressures in the Unfired Pressure Vessel

* Abstract of paper presented at the tenth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors.

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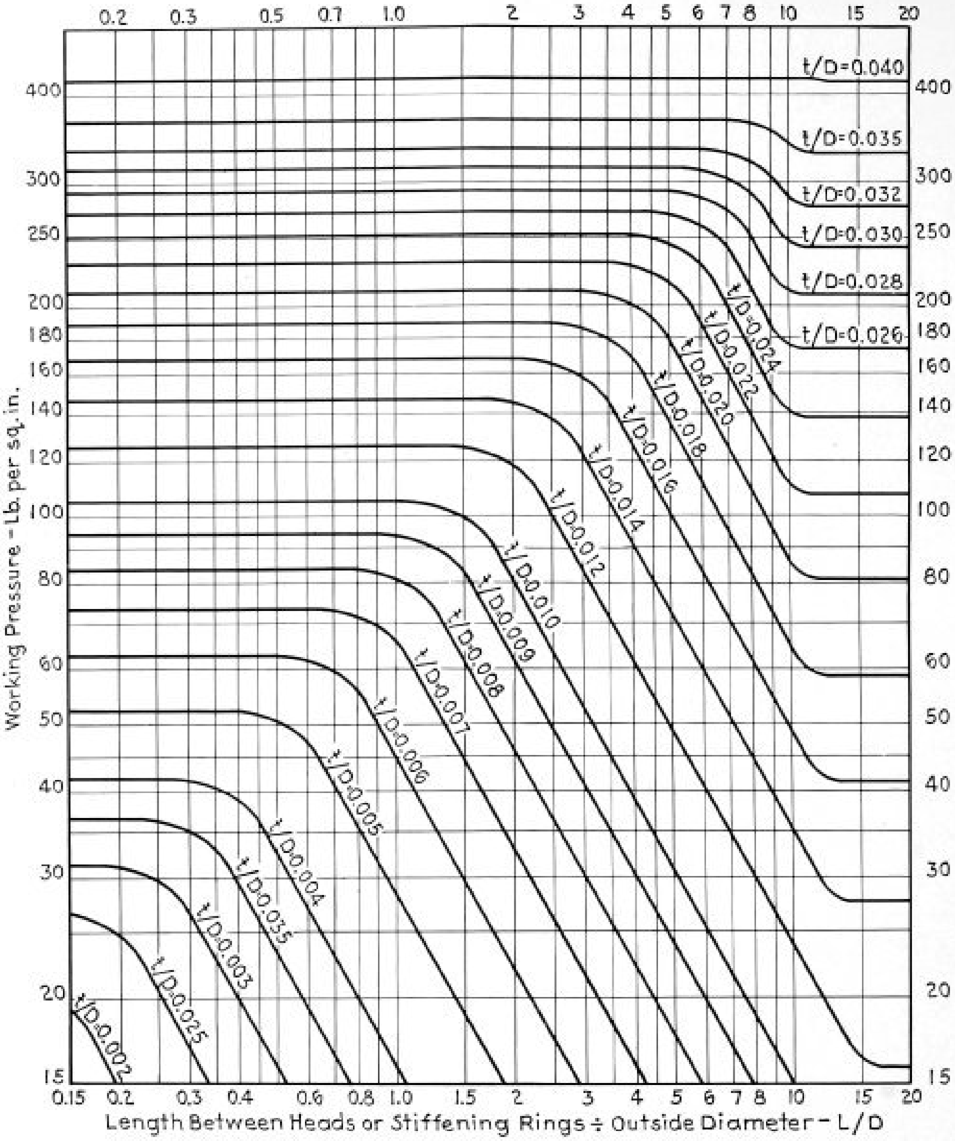


Fig. 2

Code of the American Society of Mechanical Engineers relate only to vessels of the three general types shown in Fig. 1 and only when they are built of ordinary boiler steel or material having practically the same physical properties.

The vessel (*A*) in Fig. 1 will be recognized as a plain cylindrical vessel which might be used as a vacuum tank, the external pressure being only that of the atmosphere. (*B*) Fig. 1, represents the typical, cylindrical, jacketed vessel or autoclave. (*C*) Fig. 1 is a type of vessel, extensively used, of which a fat melter in the packing industry is typical. It has been found by experiment that vessels having the same ratios of length to diameter and of thickness to diameter will collapse at the same pressure. For instance, two vessels, one of which is 100 inches diameter, 200 feet long, of 1-inch plate, the other 50 inches diameter, 100 feet long and ½-inch plate have the same collapsing pressure, the t/D and L/D in each case being 0.01 and 2 respectively.

Because of the fact that the thickness, diameter and length of a vessel all enter into the computation for its strength, and in a very involved manner, it has been found convenient to refer to the t/D and L/D ratios rather than the actual values of thickness, diameter and length. Furthermore, since the mathematics involved in making calculations are very complex, charts have been devised to make easier the solution of any given problem. The chart applying to cylindrical vessels of the three types shown in Fig. 1, when constructed of ordinary boiler steel or similar material, is given in Fig. 2.

The extreme right-hand side of this chart applies to those vessels which have a great length as compared to the diameter. That is to say, the L/D ratio is high and in such vessels the ends do not give any support to the middle section. Therefore, the collapsing pressure or the safe working pressure is independent of their length. The middle section of the chart where the lines are diagonal represents those vessels in which the strength is affected by the length. It will be noted that as the ratio of length to diameter decreases, the working pressure increases.

At the left-hand side of the chart the lines again become horizontal. This section represents those vessels that fail because of yielding of the material irrespective of the strength afforded by the heads or supporting rings. That is to say, as a design is shortened in length, a point is reached where failure will occur in the same way as a short column. Just as with a short column, where the strength remains the same regardless of its length, the design of a cylindrical vessel reaches a point where failure will occur by yielding and the collapsing pressure or safe working pressure is not changed by designing a shorter vessel.

Just for a moment, take a vessel which has a length twice as great as its diameter. With a given thickness and a given diameter that vessel at t/D ratio 0.8 would have an allowable pressure of 45 pounds. If that vessel were twice as long, in other words the length were 4 times the diameter and the L/D ratio up to the 0.8 line, we would find the allowable pressure is 22 pounds. When we make the vessel longer the heads do not give the same support as they did when they were closer together, and therefore there is a lower safe working pressure on those vessels. So that you see the length and the diameter length ratio of a vessel under external pressure are very important whereas they have no bearing on a vessel under internal pressure.

In the calculation of a vessel under external pressure, the length may be taken as the difference between any two points where the support is sufficient adequately to hold the vessel in circular form. The heads on a vessel whether flat, dished, or hemispherical, are considered to be adequate supports of this nature. For heads that are riveted to the shell, the length of the vessel may be taken as the distance between the head seams. In the case of heads butt welded to the shell, the length should be taken as the distance between the points where the curvature of the heads begin.

Supporting rings may be attached to vessels under external pressure and, provided they are of adequate strength, the length L may be taken as the distance between such supports. The method for determining whether ring supports are adequate will be discussed later.

To illustrate the distance that is to be taken as L in the application of this chart, a few typical constructions are shown in Fig. 3. In the lower left-hand sketch of this figure, several designs of reinforcing rings, and possible methods of attachment are shown.

Although the rules given in the A.S.M.E. Code for vessels subjected to external pressure are primarily intended for the guidance of designers these rules may also be used to determine whether a vessel already in use has been properly designed and whether it is adequate for the pressure to which it is subjected.

The simplest illustration of a vessel under external pressure is a vacuum tank. As a typical case, assume a tank of riveted construction, with butt type longitudinal joints, a diameter of 5 feet, a length of 20 feet between the head seams and a thickness of the shell plate of ½ inch.

In this vessel the L/D ratio is 20/5 or 4. The t/D ratio is 0.5/60 or 0.00833. Carefully note that both the

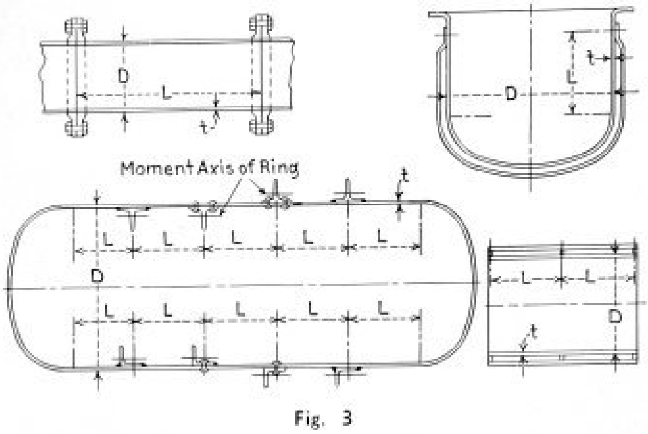


Fig. 3

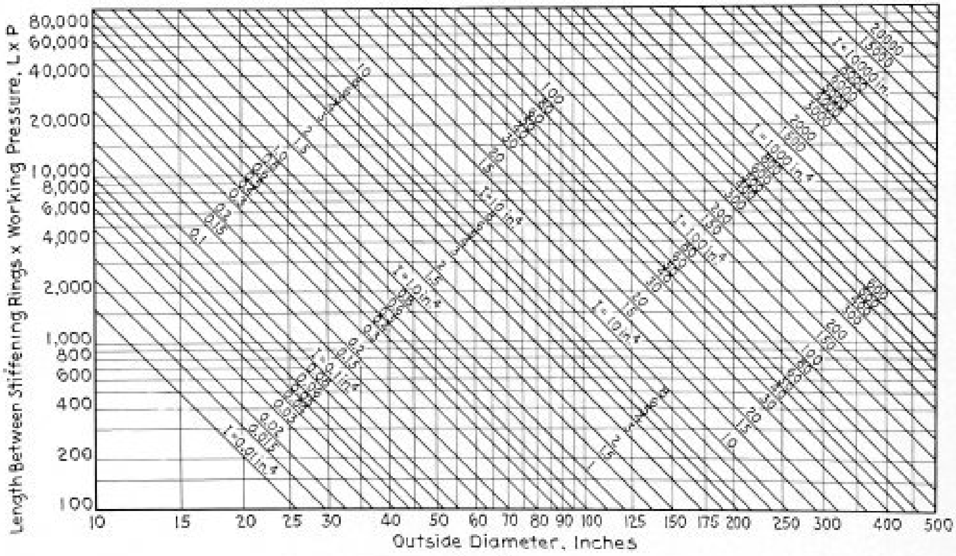


Fig. 4

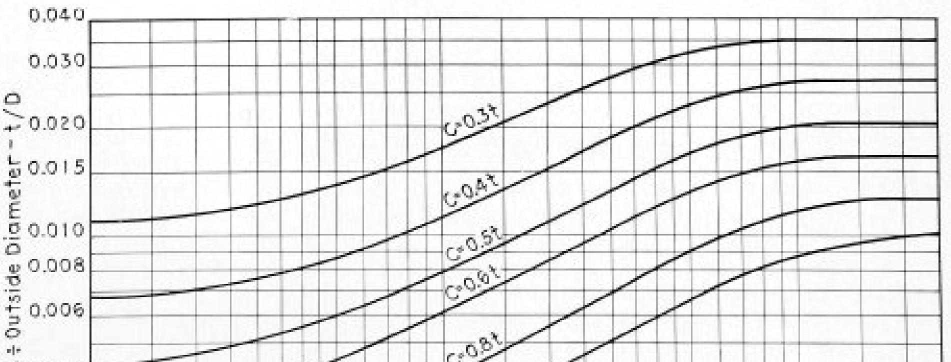


Fig. 5

numerator and the denominator of these ratios must be given in the same units of measurements, that is, both must be in inches or both in feet.

Referring to the chart, Fig. 2, find the vertical line marked "4" representing the L/D ratio of that amount. Follow vertically on this line to the line representing a t/D ratio of 0.00833. While there is actually no such line, there is one for 0.008 and one for 0.009, so that the line for 0.00833 would be about one-third the distance between the two or approximately at 25 pounds, and the vessel would be adapted to that pressure. It is evident, therefore, that the vessel is entirely satisfactory for use as a vacuum vessel which is subjected to only 15 pounds external pressure.

The question may be asked how thin a vessel 5 feet in diameter and 20 feet in length, may be and still be satisfactory for use as a vacuum tank. At the bottom of the chart find the horizontal line for 15 pounds pressure and note that the vertical line for L/D crosses this 15 pound line a short distance to the left of the t/D line for 0.007. Estimating the distance between the t/D line 0.006 and that for 0.007 it will be found that the L/D line 4 crosses the 15-pound line at a t/D value of 0.0069. In other words, the vessel in question should have a t/D ratio of 0.0069.

If the ratio of t/D is 0.0069 then the thickness will be that ratio multiplied by the diameter. In other words,

if $t/D = 0.0069$
then $t = 0.0069 \times D$
and since D is 60 inches
$t = 0.0069 \times 60 = 0.414$ inch

As a second illustrative example, consider a jacketed autoclave, as shown at the upper right corner of Fig. 3, with a diameter of 45 inches, a length of 36 inches, and a thickness of $\frac{7}{16}$ inch or 0.4375 inch. The desired working pressure is 140 pounds per square inch, but it is not certain that the thickness is sufficient.

In this case the L/D ratio is 36/45 or 0.8, and the t/D ratio is 0.4375/45 or 0.0097. Following up the vertical line 0.8, to a point were a line for a t/D ratio of 0.0097 might be drawn, it will be found that the allowable pressure would be only slightly more than 100 pounds. Continuing up the line 0.8 to the 140-pound line, it will be found that the required t/D value is approximately 0.0135. Since the diameter is 45 inches, the required thickness should be 45×0.0135 or 0.608 inch thus showing that the original thickness of $\frac{7}{16}$ was not sufficient. It has been stated previously that if supporting rings attached to vessels are of adequate strength the length L may be taken as the distance between such rings. The question arises as to just what constitutes adequate strength.

It will be recognized that the required size of supporting rings depends upon the outside diameter of the vessel, the length between the stiffening rings, and the working pressure. The size of such rings may be determined by the application of a theoretical formula relating to the buckling of circular rings under uniform external pressure. However, this formula is somewhat difficult to use and it seems best, both for the purpose of clarification of the matter and for readiness of application of the code, to obtain the required size of such rings from a chart which is shown in Fig. 4.

In applying this chart from a design standpoint, the product of the length, in inches between the centers of the stiffening rings and the working pressure is calculated and the line representing this product is located on the side of the chart. Follow horizontally along this line until the vertical line representing the outside diameter of the vessel in inches is reached. At the intersection of these horizontal and vertical lines there will be found the value for the required moment of inertia of the stiffening rings. For the purpose of illustration, consider the vacuum vessel 5 feet in diameter and 20 feet long that has been mentioned previously. That vessel had an L/D ratio of 4 and it was found that the required thickness would be 0.414 inch. Suppose that it were decided to use a single stiffening ring in the middle of the vessel with the idea that the thickness of the shell might be decreased. If such construction were used, the L/D ratio would be 2, the t/D ratio would be 0.00525, and the required thickness of the shell would be 0.315 inch. For this construction, the L, or the length between the head and the ring, would be 10 feet, or 120 inches. The working pressure is 15 pounds so that the product of these two is 1800. Locating this value on the chart for stiffening rings and following the line horizontally to a diameter of 60 inches, it will be found that a moment of inertia of 2.5 is required. By reference to structural steel tables it can be seen that an angle $3\frac{1}{2}$ inches by $\frac{3}{8}$ inch thick would be satisfactory if the 3-inch leg were attached to the shell. Of course any other shape having a moment of inertia of 2.5 would be satisfactory. For instance, a rectangular bar of iron $2\frac{3}{8}$ inches by $2\frac{3}{8}$ inches would meet the requirement.

Instead of one ring two or even more could be used and it would be found that for this particular vessel every increase in the number of rings would result in a thinner plate and a smaller size of stiffening ring. The limit to such construction would be an economical one and consideration would have to be given to the relative cost of additional rings and the expense of attaching them as compared to the cost of the vessel without rings or with a small number of rings.

While the above discussion has been from the standpoint of design, the same principles can readily be applied to the determination of the safe working pressure for a given vessel. In making such a determination it is well to first determine to what pressure a vessel would be limited by the size and spacing of the rings attached to it. If those rings are found adequate for the desired pressure, then the question of whether the shell plate of the vessel is of sufficient thickness may be investigated.

Supporting rings may be either internal or external. It will be apparent that when internal rings are used, it is sufficient merely to secure the rings in place so that they will not move. In the case of outside rings it is necessary to provide sufficient rivets or a sufficient amount of welding to adequately secure the rings to the shell. The size and spacing of such rivets and the minimum amount of welding are given in the code.

In developing methods for the calculation or design of cylindrical vessels under external pressure, it has been assumed that such vessels are truly cylindrical, and it will readily be appreciated that out-of-roundness of such vessels decreases their resistance to collapse. On the other hand, some degree of out-of-roundness must be permitted since it is practically impossible to construct a vessel that is truly cylindrical. The decrease in strength by the out-of-roundness that is permitted is taken into consideration in the factor of safety required.

The effect of out-of-roundness on decreasing the resistance of a vessel to collapse depends on both the L/D and t/D ratios and it, therefore, is impossible to give the permissible tolerance as a fraction of the diameter or of the thickness of the vessel. While formulae have been developed for determination of the permissible tolerance, they are rather complex and, again for simplification of the problem, a chart has been made as shown in Fig. 5.

Again referring to the vacuum vessel first considered

(L/D of 4, t/D of 0.0069, and t of 0.414) it will be found from Fig. 5 that an eccentricity of 0.9 times the thickness would be permitted. Since the thickness of shell is 0.414 the permissible out-of-roundness is 0.372 or approximately 3/8 inch.

The degree of eccentricity is the difference between the maximum and minimum diameters of the vessel and should be measured at several points. In the case of vessels with lap-seam construction, the amount of eccentricity may be the value obtained from the chart plus the plate thickness. Whereas this provision permits a greater degree of eccentricity in vessels of lap construction, on the other hand such vessels are permitted only one-half the pressure that would be allowed on a vessel of butt-seam construction.

Still another point to which consideration must be given in connection with cylindrical vessels under external pressure is the manner in which they are supported, which should, in all cases, be such that no concentrated loads are imposed on the shell. In the case of horizontal vessels they should be supported at the heads or from the reinforcing rings, if such rings are used. If no supporting rings are provided and if the vessel is of such length that it would sag or be unduly stressed should the only support be at the heads, then intermediate supports should be provided but these should be in the form of a saddle, the arc of which extends over at least one-third of the circumference. On vertical vessels the legs or brackets that might be used should not be attached directly to the shell but to a substantial ring which in turn is secured to the shell, thus distributing the load.

Russia Building Locomotive Flash Boiler

By G. P. Blackall

It has just been announced from Moscow that the Kolomensk Locomotive Works near that city is shortly to build a new type of flash boiler with condenser, which will consume considerably less fuel than existing locomotive boilers. The locomotive will be able to travel 7000 miles without having to take water.

The new boiler is designed for a pressure of 1400 pounds per square inch. Though only 20 tons heavier than the Russian "IS" locomotive, the new locomotive will be able to develop 4000 horsepower, as against the 2500 horsepower of the "IS" locomotive, with a consumption of 60 percent less fuel.

The Kolomensk Works is at present building an experimental 600-horsepower locomotive of the new design, and, when this has been thoroughly tested, building will start on the 4000-horsepower locomotive.

Large Welded Pressure Vessel

Four 50-ton evaporators recently made in the United Kingdom for the new sugar refinery of Tate and Lyle, Ltd., at Silvertown, London, are claimed to be the largest welded pressure vessels ever made to Lloyd's Class 1 code.

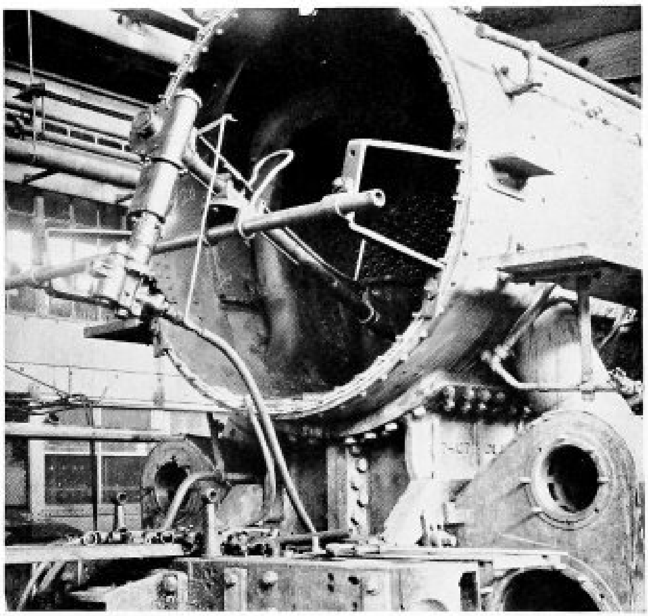
These vessels, which have been made by G. A. Harvey and Co., Ltd., are 26 feet 9 inches high and 11 feet in internal diameter. They are designed for a working pressure of 250 pounds per square inch on the shell. Each consists of two shells, both 10 feet 4 inches high, and a domed top and bottom. The bottom shell, known as the calandria section, is fabricated of 1 13/32-inch plate, and has two tube plates, each in one piece, 1 inch thick. There are 1792 tubes of 1½-inch bore welded into and connecting the two tube plates.

The calandria section was subjected to a test pressure of 375 pounds per square inch and the upper shell 285 pounds per square inch. All the main seams were X-rayed, and altogether about 1200 X-ray photographs were taken of the welding of the four vessels.

Two Boiler Shop Tools

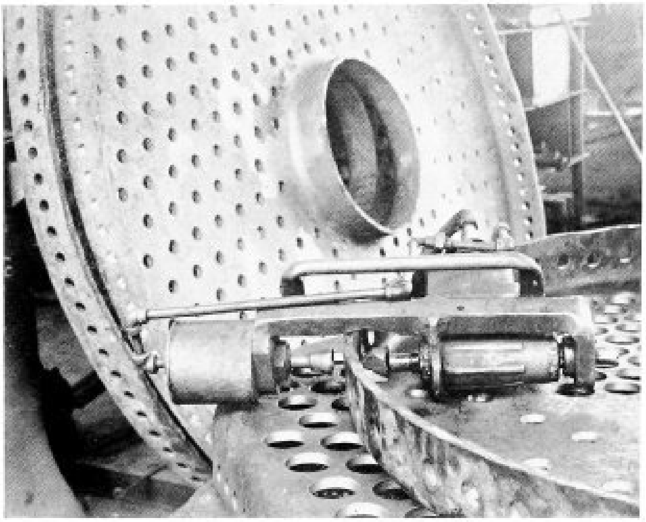
Two devices which assist greatly in connection with boiler works at the Denver, Colo., shops of the Chicago, Burlington & Quincy are shown in the illustrations. The first is a power attachment for cutting off and rolling flues in the front end. This device consists of a reversible air motor with power attachment and worm-gear drive to a 6-foot cutter bar, this bar being mounted on a 3-inch horizontal steel tube suitably supported by brackets bolted to the boiler front ring. A gear box makes two speeds available for use, dependent upon whether large flues or small tubes are being cut. Reference to the illustration shows that the cutter bar is capable of swinging vertically or sliding horizontally on the 3-inch horizontal tube. The machine may thus be used for cutting an entire set of flues without resetting the supporting bar and brackets.

The cutter bar has a telescoping bar and universal socket arrangement to accommodate various lengths, dependent upon the angle of cutter bar adjustment necessary for any particular tube or flue. Only one knuckle joint is necessary with this arrangement, and in view of the rigidity of the drive, very satisfactory work is performed and a longer life assured for the cutters. The safety factor is also important, as the machine is strongly made and designed so as to present little opportunity for personal injuries. The rubber hose connection to the air motor and conveniently accessible control levers required for one-man operation.



Efficient power attachment for cutting off and rolling boiler tubes and flues

The device shown in the second illustration is an unusually compact and effective arrangement for countersinking the rivet holes in flue sheets. This consists of



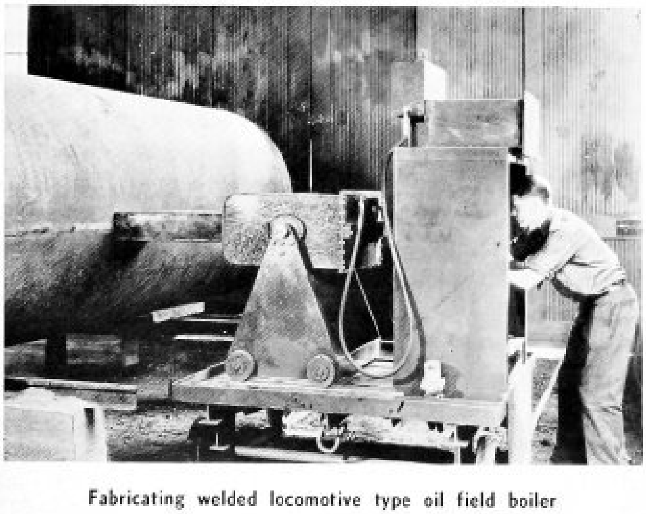
Easily handled device for counterboring rivet holes in flue sheets

a steel frame to which is attached an angle motor for operating the countersink and a small cylinder and air-operated plunger which backs up the countersink and provides the necessary feed. A convenient handle is welded to the frame for greater ease in adjustment of the device and the air line to the cylinder is installed and connected so that when air is applied to operate the motor, pressure in the cylinder pulls the countersink into the rivet hole. The overall length of this device is approximately 24 inches. The cylinder has a 4-inch bore and 3½-inch stroke. The air line is made of ¼-inch steel pipe and the air pressure used is that of the shop line, or about 100 pounds per square inch.

Locomotive Boiler Built with Welded Barrel

What is thought to be the first high-pressure boiler ever made with welded barrel and dome, under U-68 (Class I) rules of the A.S.M.E. Code for fusion welded vessels, was recently completed by Farrar and Trefts, Inc., Buffalo, N. Y.

The new boiler is of locomotive type and is for use in oil fields. The barrel is 16 feet 6 inches long, 62½ inches outside diameter and made of steel plate 1.15 inches thick, electrically welded by the shielded-arc process with equipment supplied by The Lincoln Electric Company, Cleveland.

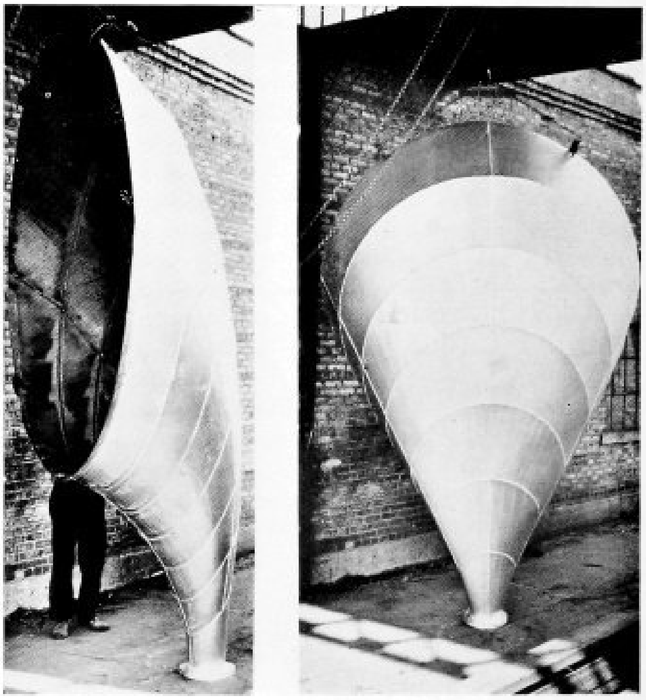


Fabricating welded locomotive type oil field boiler

Welded construction of the barrel eliminated a large amount of calking of seams which was necessary with the former method of construction employing riveting. The two longitudinal welds of the barrel were hammer tested at 575 pounds and leak tested at 700 pounds hydrostatic pressure, revealing high quality leak-proof seams. The welding was done with "Fleetweld 6" electrodes.

Welding Used in Odd Fabricating Job

This horn-shaped structure, spreading out from 8 inches diameter at the bottom to 8 feet at the top, was once a single flat piece of $^3/_{16}$-inch ingot iron. The structure is still a single piece of metal—only the shape



Welded funnel outlet for sewage disposal

is different. It was made by cutting out 26 pieces, then fusing them all together into one integral unit by the shielded-arc process of electric welding. The structure is now being used as an outlet fitting for the cone of a clarifying tank in sewage disposal work. It was fabricated by the Farrel Manufacturing Company, Joliet, Ill.

Atlantic City to Have 1937 Metal Congress

The 1937 Metal Congress and Exposition will be held October 18 to 22, in the Atlantic City Auditorium, according to an announcement made recently by W. H. Eisenman, managing director of this annual metal show and national secretary of the American Society for Metals, after a meeting of the Society's board of trustees in Cleveland.

Practical Plate Development—XIX

Layout of a Smokestack Breeching

By George M. Davies

A reader has requested that a method of developing the smokestack breeching as illustrated in Fig. 158 be given in connection with the Practical Plate Development series.

The smokestack breeching illustrated in Fig. 158 is of the conventional type, with a round top and a wash-boiler section where it joins the boiler. For convenience in laying out the breeching, all lines have been taken on the neutral axis of the plate and all joints are assumed to be welded, no allowance being made for lap joints.

The breeching to be developed is shown in Fig. 159, the elevation; Fig. 160, the plan, and Fig. 161, the end view. The elevation and plan are readily constructed from the illustration in Fig. 158. The connection between the breeching and the boiler in the end view, Fig. 161, must be obtained by projection from Figs. 159 and 160, as follows:

Divide the semicircle *E'-B'-F'* of the plan, Fig. 160, into any number of equal parts, the greater the number of equal parts taken, the more accurate the final development. In this case ten were taken and the points numbered from 1 to 11 as shown. Then parallel to the center line *M-N*, draw lines through the points 1 to 11, extending same down into the elevation, Fig. 159, cutting the arc *K-B* and locating the points 1' to 11'. Next draw lines parallel to the center line *T-U* through the points 1' to 11', Fig. 159, extending these lines into the end view, Fig. 161. In the end view, Fig. 161, on the center line R-S construct the profile, Fig. 162, of the semicircular end of the wash boiler section and divide this section end into the same number of equal parts as was taken in the plan view. Number these points from 1 to 11, corresponding to the same points in the plan view, Fig. 160.

Then parallel to the center line *R-S*, draw a line through the point 1 of the profile, Fig. 162, and extend the line into the end view, cutting the line drawn from the point 1' of the elevation. The point 1" in the end view, Fig. 161, is thus located, and in like manner, draw a line through the point 2 of the profile, Fig. 162, and extend it into the end view cutting the line drawn from the point 2' of the elevation thereby locating the point 2" in the end view, Fig. 161. Continue to use this method and locate the points 3" to 11" of the end view. Connect the points 1" to 11" with a line completing the end view, Fig. 161.

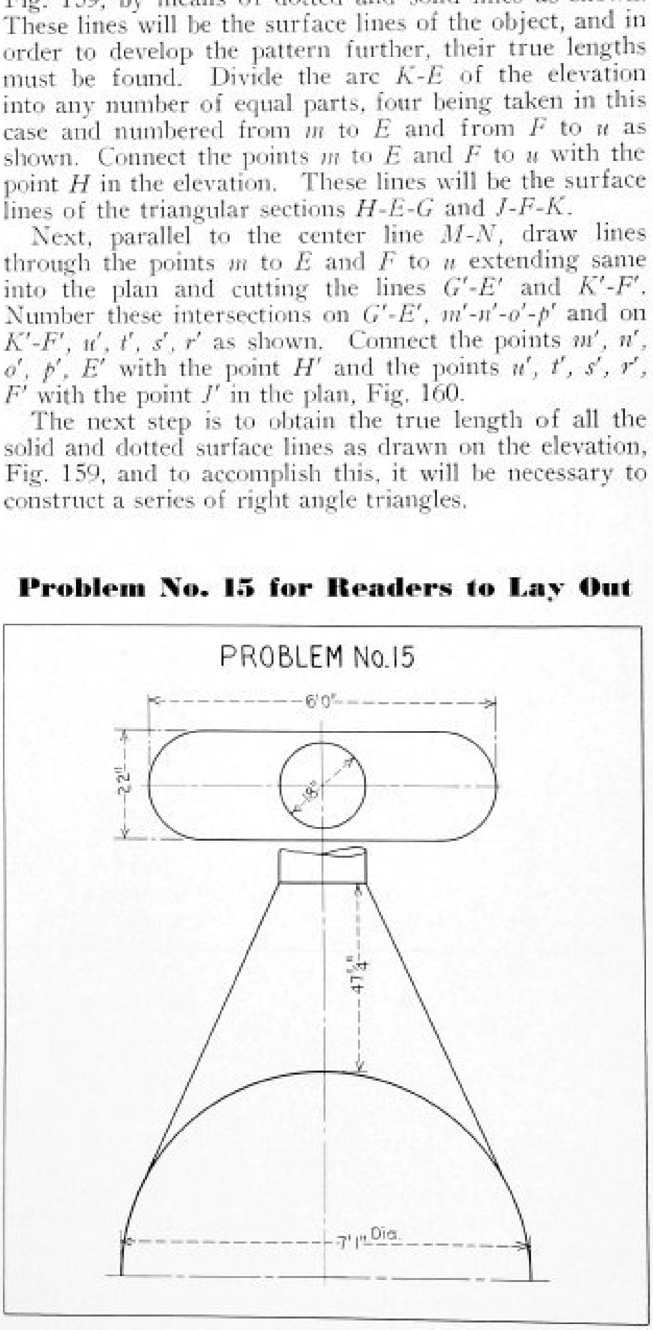
In examining the plan view, it will be noticed that the center line *M-N* divides the breeching into two symmetrical halves and, therefore, a development of one half of the plan view will be all that is necessary; a duplicate of this development will complete the layout of the breeching.

Divide the semicircle *H'-D'-J'*, Fig. 160, into the same number of equal parts as were taken for the semicircular end of the wash-boiler section *E'-B'-F'* and number these points from *a* to *k* as shown. Parallel to the center line *M-N*, draw lines through the points *a* to *k* extending them into the elevation, Fig. 159, cutting the line *C-D*. Number the intersections from *a'* to *k'*. Connect the points *a'* to *k'* with the points 1' to 11' in the elevation, Fig. 159, by means of dotted and solid lines as shown. These lines will be the surface lines of the object, and in order to develop the pattern further, their true lengths must be found. Divide the arc *K-E* of the elevation into any number of equal parts, four being taken in this case and numbered from *m* to *E* and from *F* to *u* as shown. Connect the points *m* to *E* and *F* to *u* with the point *H* in the elevation. These lines will be the surface lines of the triangular sections *H-E-G* and *J-F-K*.

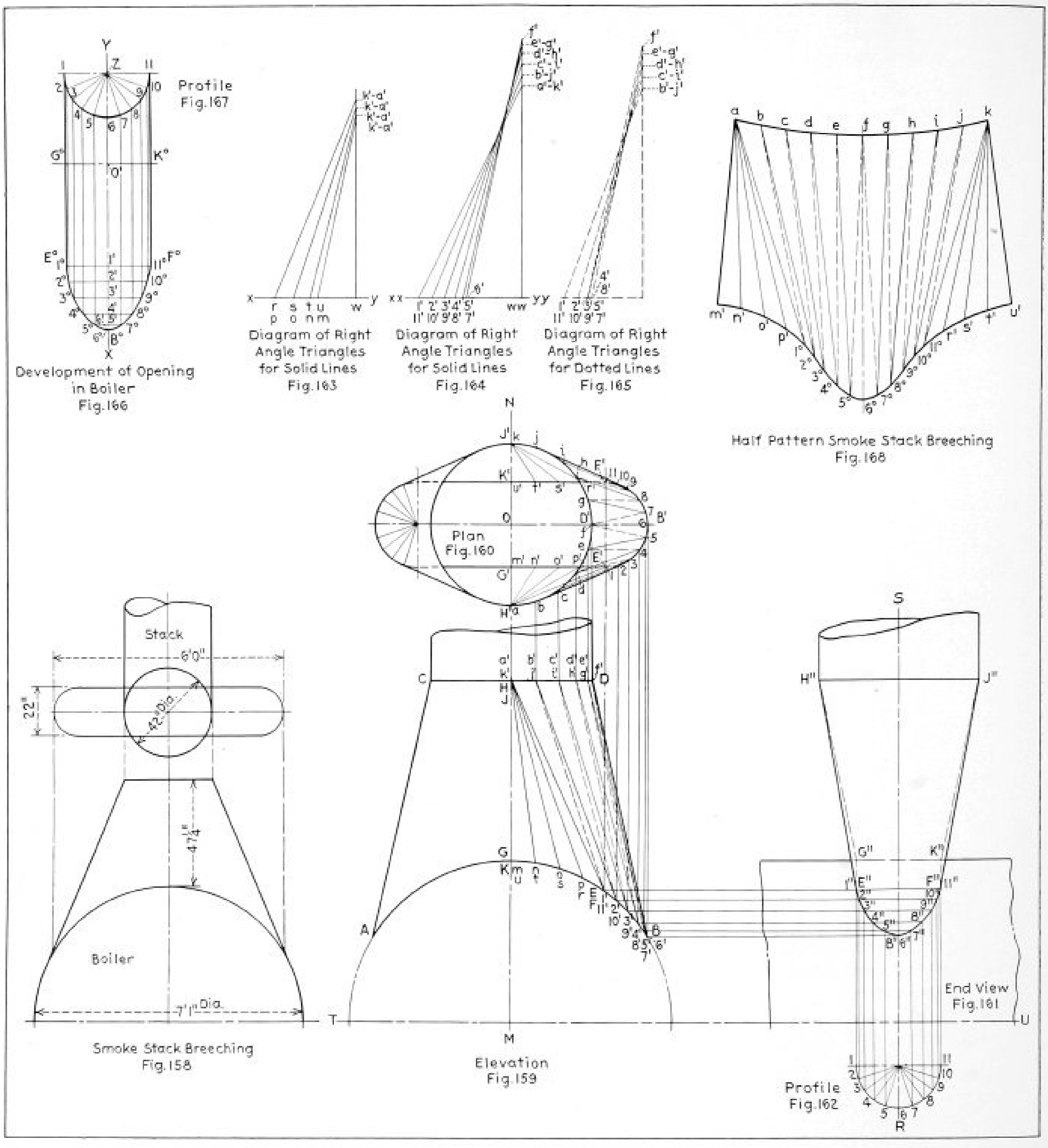
Next, parallel to the center line *M-N*, draw lines through the points *m* to *E* and *F* to *u* extending same into the plan and cutting the lines *G'-E'* and *K'-F'*. Number these intersections on *G'-E'*, *m'-n'-o'-p'* and on *K'-F'*, *u'*, *t'*, *s'*, *r'* as shown. Connect the points *m'*, *n'*, *o'*, *p'*, *E'* with the point *H'* and the points *u'*, *t'*, *s'*, *r'*, *F'* with the point *J'* in the plan, Fig. 160.

The next step is to obtain the true length of all the solid and dotted surface lines as drawn on the elevation, Fig. 159, and to accomplish this, it will be necessary to construct a series of right angle triangles.

Problem No. 15 for Readers to Lay Out



The correct solution of Problem No. 15 will be published in the February issue



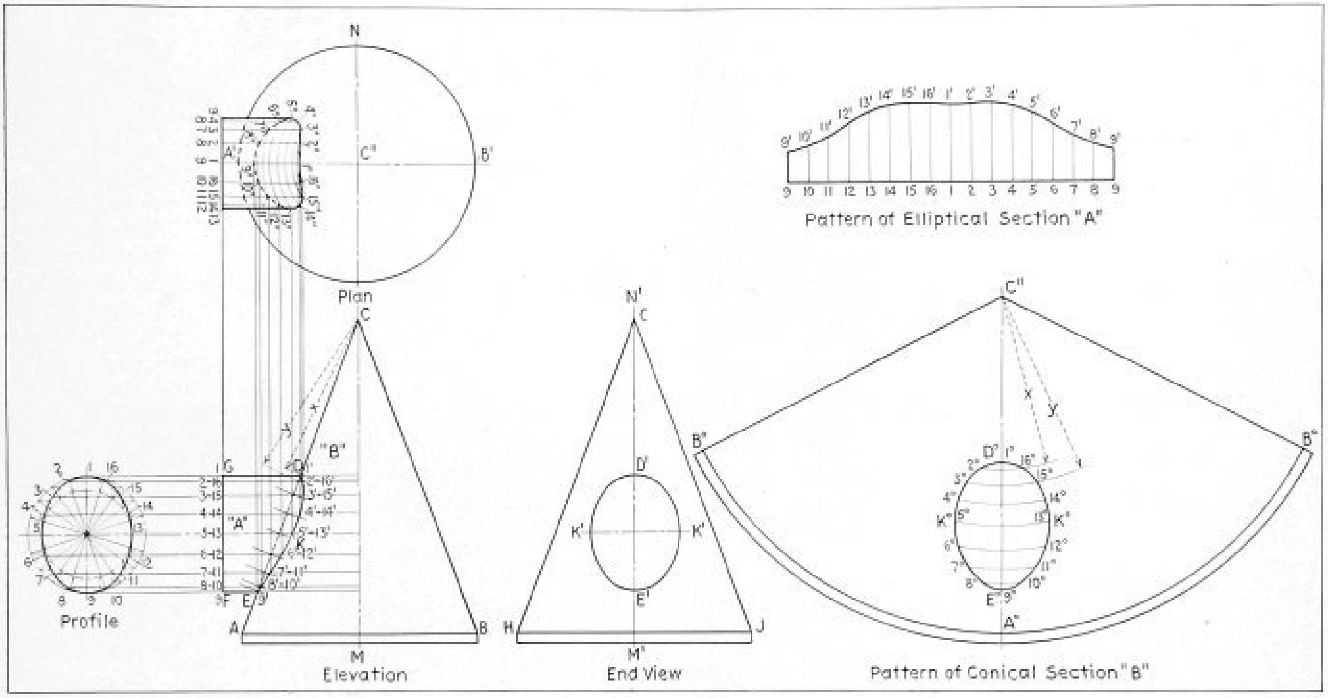
Details of layout for smoke stack breeching

Construction of Right Angle Triangles

In constructing the right angle triangles in order to obtain the true lengths of the solid surface lines of the triangular sections *H-E-G* and *J-F-K* of the elevation, draw any line as *x-y*, Fig. 163, and at *w* erect a perpendicular to it. From *w* on the base line, step off the distance *w-m* equal to *a-m'* of the plan and from *w* on the perpendicular step off the distance *w-a'* equal to *a'-m* of the elevation. Connect the points *a'-m*, Fig. 163. This line will be the true length of the surface line *a'-m* of the elevation, Fig. 159. In like manner, from *w* on the base line, step off the distance *w-n* equal to *a-n'* of the plan, Fig. 160, and from *w* on the perpendicular, step off the distance *w-a'* equal to the vertical distance between the point *n* and the line *C-D* of the elevation. Connect this point *a'* with point *n*, the line *a'-n* being the true length of the surface line *a'-n* of the elevation. Continue in this manner, taking the bases of the triangles *w-o*, *w-p* equal to *a-o' and a-p'* of the plan and *w-r*, *w-s*, *w-t*, *w-u* equal to *k-u'*, *k-t'*, *k-s'*, *k-r'* of the plan. This will also make the altitudes *w-a'* and *w-k'* equal to the vertical distances between the points *o*, *p*, *r*, *s*, *t*, *u* and the line *C-D* of the elevation, completing the solid surface lines of the triangular sections.

Problem No. 14—Correct Layout

Cone and Elliptical Intersection



Problem No. 14 appeared on page 242 of the September issue. The correct solution is published herewith in order to give our readers who have developed the problem an opportunity to check their work

The true lengths of the solid surface lines of the semicircular ends must be obtained next. Draw any line as *xx-yy*, Fig. 164, and at *ww* erect a perpendicular to it. From *ww* on the base line, step off the distance ww-$6'$ equal to f-6 of the plan, Fig. 160, and from *ww* on the perpendicular, step off the distance ww-f' equal to the vertical distance between the point $6'$ and the line C-D of the elevation, Fig. 159. Connect the points $6'$-f', Fig. 164, with a line, which will be the true length of the solid surface line f'-$6'$ of the elevation, Fig. 159.

Continue in same manner, making the bases of the triangles equal to the distances e-5, d-4, c-3, b-2, a-1, g-7, h-8, i-9, j-10, k-11 of the plan and the altitudes of the triangles equal to the vertical distance between the line C-D and the points $5'$, $4'$, $3'$, $2'$, $1'$, $7'$, $8'$, $9'$, $10'$, $11'$, respectively. Then connect the points as shown in Fig. 164, completing the right angle triangles for the solid surface lines.

The true lengths of the dotted surface lines are obtained in the same manner and are shown in Fig. 165. The bases of the right angle triangles are made equal to f-5, e-4, d-3, c-2, b-1, f-7, g-8, h-9, i-10, j-11 of the plan, Fig. 160, and their respective altitudes are made equal to the vertical distance between the line C-D and the points $5'$, $4'$, $3'$, $2'$, $1'$, $7'$, $8'$, $9'$, $10'$, $11'$, of the elevation, Fig. 159. Connect the points f'-$5'$, e'-$4'$, d'-$3'$, c'-$2'$, b'-$1'$, f'-$7'$, g'-$8'$, h'-$9'$, i'-$10'$, j'-$11'$ with dotted lines and these lines will be the true lengths of their corresponding dotted surface lines in the elevation.

Development of Opening in Boiler

Draw any line as X-Y, Fig. 166, and at O' erect a perpendicular to it. On the perpendicular, step off O'-G° and O'-K° equal to O-G' and O-K' of the plan view, Fig. 160. Through G° and K° draw lines parallel to X-Y. On these lines, step off G°-E° equal to G'-E' and K°-F° equal to K'-F' of the plan view, Fig, 160. Draw the line E°-F°, Fig. 166, and from E°-F° on the line X-Y step off the distances $1'$-$2'$, $2'$-$3'$, $3'$-$4'$, $4'$-$5'$, $5'$-$6'$ equal to the distances $1'$-$2'$, $2'$-$3'$, $3'$-$4'$, $4'$-$5'$, $5'$-$6'$ in the elevation, Fig. 159. Then parallel to E°-F°, draw lines through the points $1'$, $2'$, $3'$, $4'$, $5'$, and $6'$, extending them on both sides of the line X-Y. At the point Z on X-Y, draw the profile, Fig. 167, of the semicircular end of the wash-boiler section and divide it into the same number of parts as was taken in the plan view, Fig. 160. Number these points from 1 to 11, corresponding to the same points in the plan.

Then through the points 1 and 11, Fig. 167, draw lines parallel to the center line X-Y, extending same into Fig. 166 and cutting the line drawn through point $1'$, Fig. 166, thereby locating the points 1° and 11°. In the same manner, through the points 2 and 10, Fig. 167, draw lines parallel to the center line X-Y and extend these lines into Fig. 166 cutting the line drawn through the point $2'$ and locating the points 2° and 10°, Fig. 166. Similarly, locate the points 3° and 9°, 4° and 8°, 5° and 7°, and 6°. Connect the points $G^\circ 1^\circ$ to 6° to 11° to K° with a line, which will complete the development of the opening in the boiler.

Development of the Pattern

Draw any line as in Fig. 168 and on it step off the distance f-6° equal to f'-$6'$, Fig. 164. With 6° as a center and with the dividers set equal to 6°-7°, Fig. 166, scribe an arc. Then with f as a center and with the trams set equal to f'-7', Fig. 165, scribe a second arc, cutting the arc just drawn and locating the point 7°, Fig. 168. With f as a center and with dividers set equal to f-g, Fig. 160, scribe an arc, then with 7° as a center and with the trams set equal to 7'-g', Fig. 164, scribe another arc, cutting the arc just drawn and locating the point g, Fig. 168. Continue in this manner, making 7°-8°, 8°-9°, 9°-10°, 10°-11° equal to their corresponding distances in Fig. 166 and making g-8°, h-9°, i-10°, j-11° equal to g'-8', h'-9', i'-10', j'-11', Fig. 165, and 8°-h, 9°-i, 10°-j, 11°-k equal to 8'-h', 9'-i', 10'-j', 11'-k', Fig. 164, and g-h, h-i, i-j, j-k equal to g-h, h-i, i-j and j-k, Fig. 160, completing the pattern to the line k-11°.

With 11° as a center and with the dividers set equal to 11'-r, Fig. 159, scribe an arc, and with k as a center and with the trams set equal to k'-r, Fig. 163, scribe an arc, cutting the arc just drawn, locating the point r', Fig. 168. Continue in the same manner, making r'-s', s'-t', t'-u' equal to r-s, s-t, t-u, Fig. 159, and k-s', k-t', k-u' equal to k'-s, k'-t, k'-u, Fig. 164, completing the pattern to the line k-u'.

From the line c°-f' develop the opposite side of the pattern in the same manner, completing the half pattern of the breeching. A duplicate of this pattern will complete the full pattern of the breeching as shown in Fig. 158.

Baldwin-Southwark Develop Weld Tester

A new hydraulic machine for accurately testing the strength of spot welds has been developed and built by the Baldwin-Southwark Corporation, Philadelphia, for the Edward G. Budd Manufacturing Company. This 10,000-pound tension testing machine is supplied with a round base for rolling from place to place and a hoisting hook for moving with a crane. It is a completely self-contained unit having an overall height of 70 inches, an 18-inch diameter steel base, a low center of gravity, and weight of approximately 800 pounds.

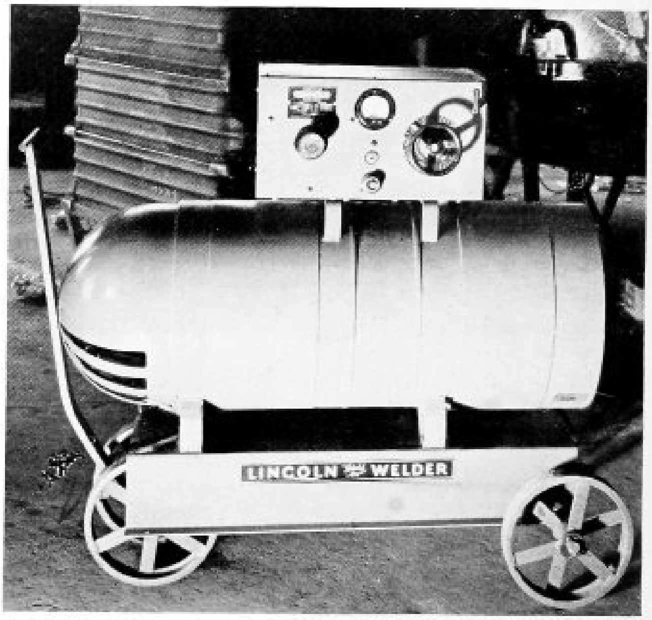
An 8-inch precision dial indicates the load. Fluid under pressure is pumped by a gear pump situated in the base of the machine. This pump is direct-connected to a ¼-horsepower motor. A specially designed type of self-alining, lever-operated, renewable file-face grips is used. These grips are so designed that hard, sharp faces can be quickly installed at a very low cost, being made of short sections of machine cut files. The upper grip is of the open face type, while the lower grip is of the closed type with wide angle entrance. These grips will accommodate offsets in welded specimens from the smallest gage to ¼-inch thick without using backing plates or liners. Specimens up to 1¼ inches wide can be tested.

Valve Leaks Cause Boiler Explosion

A leaky stop valve on the pilot light and a leaky plug cock on the main burners of a gas-fired power boiler—No. 2 of a pair in a California plant—caused a furnace explosion which did $2500 damage to the boiler setting. The escaping gas, which had filled the furnace and flues of the idle boiler, was ignited through cracks in the center brick wall between the two boilers five minutes after the No. 1 burner had been lit. The rear wall was bulged and pushed back about nine inches. The right-side wall was blown out entirely, leaving no support under that side of the boiler, as the boilers were set on brickwork instead of being supported from the beams. This caused an excessive strain on the main steam pipe which held the boiler in place. Fortunately, there was no water in the boiler at the time, for that added weight would probably have caused the piping to break and the boiler to fall. *The Locomotive.*

Continuous Dual Arc Control Welder

A new line of single operator arc welders has recently been made available by The Lincoln Electric Company, Cleveland. These new welders will be known as the "Shield Arc SAE" and will supersede the present type of "Shield Arc" which have been on the market for the last six years. The predominating feature of this new arc welder is a new method of arc control which makes possible the adjustment of both arc heat and arc penetration in a continuous sequence of fine increments. It is claimed this continuous dual control assures absolute uniformity of performance at every control setting and adds greatly to the successful operation of arc welding. These claims are based on the operation of a large number of this type welder which have been in actual service in customers' plants for the last year.



New continuous S A E dual control arc-welder

It is a well-known fact that for certain types of arc welding a low voltage with wide range of current control is desired. For other types of work a higher voltage with the same wide range of current is highly desired. The new welder therefore permits the use of the correct voltage and current for all classes of work in the range of each size of machine.

P.R.R. Research Activities

How the Pennsylvania, through research and experimentation, utilizes the advances of science, new inventions and improved technical processes for the improvement of its freight and passenger service is told in a special report which has recently been made public.

Committee Reports on Dust Control

The report of the preventive engineering committee of the Air Hygiene Foundation, written by Professor Philip Drinker of Harvard, chairman, and other technical specialists on the committee, advises that engineers in the "dusty trades" can and should cut heavy dust concentrations below the present limits warranted by medical knowledge. This action is important, the report explains, not only to further safeguard the health of workmen but to give employers the maximum protection against unjust claims.

Concerning the size of dust particles, the report observes that much has been made of the fact that particles found in autopsied lungs are of the order of 1 micron (1/25000 of an inch)—about like the common bacteria. It is argued, therefore, that the human anatomy and physiology exercises "some phenomenally accurate size grading which excludes larger particles."

The report says "there is no reason whatever to look for any such mysterious explanation. The sizing is done in the air before the dust is breathed and not by the man after it has been breathed." It is pointed out that the larger particles tend to fall from the air by their own weight and that "only those small enough to act as part of the transporting air stream are likely ever to reach the lungs."

"In diseases such as silicosis and asbestosis, particles must reach the alveoli (minute air sacs of the lungs) or no silicosis or asbestosis results. In maladies like hay fever, the harm is done by particles which may be 15-30 microns instead of 1 micron.

"Toxic dusts such as lead and manganese are much more likely to produce ill effects if breathed than if swallowed. The reason for this difference is physiological; it is established and should not be ignored in dust control problems. Again, common-sense tells us that the finer particles of lead are vastly more apt to be breathed than the larger.

"It follows then that dust control for hygienic reasons should be aimed at the fine rather than the coarse particles. Continuing this argument to its logical conclusion, if one could avoid use of 1 micron dusts or less, or exclude them from the dust which passes a 325-mesh screen, nearly all dust diseases would be eliminated. This is not at all an academic idea, for de-dusting processes are not new and are being applied in many industries. If some of the mechanical ingenuity which is now being applied unthinkingly to creating 1 micron dust were directed to ways for avoiding it, probably it would be discovered that dusts which are too large to be breathed would serve many processes just as well as those which are around 1 micron in size."

The report includes a table giving latest available information on the minimum air velocities necessary in certain industries to insure the maintenance of dust concentrations at safe levels.

The preventive engineering committee asserts that many firms have neglected heavy dust concentrations in cases where the dust is of no proven harm, and adds:

"There is no satisfactory medical answer at present to this question, but the engineer is making a bad mistake if he lets men breathe heavy dust concentrations of any material. If no other reason for dust control can be found, then one should read transcripts of some of the recent suits at common law in which fantastic damages for alleged silicosis were granted to men who breathed dust containing little or no silica. The courts and compensation boards are not impressed with subtle distinctions between dusts with 10 percent and 40 percent quartz, especially when medical experts are reluctant to make definite statements as to the comparative significance of such differences.

"It would be well to realize that men working in dusty trades suffer far more from respiratory troubles of all kinds than do men who work in clean air. The evidence that excessive dustiness of any kind is harmful is beyond argument."

The committee attributes the handicap in this general field to the lack of fundamental data and recommends a number of specific engineering researches for the Foundation to undertake in the coming year.

Republic Appoints Special Representative

William Hogenson has been named special representative on Toncan Iron enameling stock, according to an announcement by F. H. Ramage, manager of sales promotion, Republic Steel Corporation. His work will be in conjunction with that department under the new Product Development Division. Mr. Hogenson comes to Republic with a background of technical and business training gained at the universities of Michigan and Chicago, and a close association with the enameling industry through his most recent connection, Chicago Vitreous Enamel Products Company.

Engineering Experiments Bulletins

The Engineering Experimental Station of the University of Illinois has issued recently a series of bulletins dealing with a variety of engineering problems. Bulletin No. 283, written by Frederick G. Straub, deals with "A Study of the Reactions of Various Inorganic and Organic Salts in Preventing Scale in Steam Boilers." Bulletin No. 284, dealing with "Oxidation and Loss of Weight of Clay Bodies during Firing," was written by William R. Morgan. Bulletin No. 285, "Possible Recovery of Coal from Waste at Illinois Mines," was written by Cloyde M. Smith and David R. Mitchell. Bulletin No. 286, by Hardy Cross, discusses and describes an "Analysis of Flow in Networks of Conduits or Conductors." Copies of these publications may be obtained without charge upon application to the Engineering Experimental Station, Urbana, Ill., up to March 1, 1937, or until the supply is exhausted.

Byers Appoints New Manager of Sales Promotion

M. J. Czarniecki, vice-president in charge of sales, A. M. Byers Company, Pittsburgh, announces the following appointments that were made effective November 2, 1936:

George B. Cushing as manager of sales promotion. Mr. Cushing came with A. M. Byers Company in 1928 to organize and head the present advertising department. Subsequently in 1931 he organized a technical promotion group now known as the Engineering Service Department.

B. D. Landes, who has been in the technical group since its inception, has been appointed manager of the Engineering Service Department.

T. C. Winans, who has been in the advertising department since 1930, has been appointed advertising manager.

Both the manager of the engineering service department and the advertising manager become a part of the

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

VOLUME XXXVI NUMBER 12

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EDITORIAL STAFF: H. H. Brown, Editor. L. S. Blodgett, Managing Editor. H. W. MacDonald, Associate Editor.

BUSINESS MANAGER: Warner Lumbard.

Contents

newly formed sales promotion group headed by Mr. Cushing.

R. H. Gardner, formerly of the Washington, D. C., office of A. M. Byers Company, has been appointed manager of pipe sales and will take over all sales management duties in connection with wrought iron and steel tubular products.

Applications of Welding Studied

Realizing the need for co-operative development of the industrial applications of the electric welding process, the electric welding section of the National Electrical Manufacturers' Association has established development headquarters in the Frick Building, Pittsburgh. The welding section has initiated a program of co-operative industry development to investigate the electric welding market and determine the possibilities of extending it.

It has been conservatively estimated that by securing the widest possible adoption of applications which have been definitely successful, the use of electric welding in the manufacture of heavy machinery can be increased many fold. As a first step therefore, the program will concentrate on the converting of cast parts to welded steel in machinery construction.

H. S. Card, formerly editor of the *Welding Engineer*, has been appointed development director of the welding section and will be in charge of the Pittsburgh office.

D. L. Mathias Joins Metal and Thermit Corporation as Research Engineer

The Metal & Thermit Corporation, 120 Broadway, New York, announces that D. L. Mathias joined its staff on November 2 in the capacity of research engineer. He is the inventor of a number of types of welding electrodes and processes; and at the Metal and Thermit Corporation will be in charge of electrode research and development.

Trade Publications

Riveted Plates.—A pamphlet describing the construction of a large tunnel shield fabricated by riveting has been issued by the William B. Pollock Company, steel plate fabricator, Youngstown, O.

Blast Cleaning.—The Pangborn Corporation, Hagerstown, Md., has issued bulletin No. 201a on the Pangborn type RA-2 Rotoblast cleaning unit. This device is used for the cleaning of castings and forgings of various metallic materials and steel products of innumerable shapes and sizes and operates without the use of condensed air.

Airco Acetylene.—A booklet entitled "Airco Acetylene" has been prepared by the Air Reduction Sales Company, New York, and gives a concise presentation of the story of acetylene versus various other fuel gases. A diagram worthy of consideration is included in the booklet and shows the comparative consumption of oxygen by the various fuel gases.

Forging Presses.—The Chambersburg Engineering Company, Chambersburg, Pa., has published recently a new catalogue on the Chambersburg "United" high-speed steam-hydraulic forging presses. A complete description is given of the operation of the various types of presses. Illustrations are shown of installations in various industries and tables of dimensions of the complete line of presses are included.

Monel Metal.—A bulletin entitled "Strength Plus" has been recently published by the International Nickel Company, Inc., New York, that describes the solution to scores of metal problems encountered by the engineer. This bulletin, profusely illustrated, covers specific problems in engineering fields from hydroelectric and steam-power plants to highway maintenance, refrigeration and automobiles, in which applications of Monel can be used successfully.

Steam Generating Equipment.—A new boiler catalogue, No. 102, of striking design and appearance, has been recently published by the Edge Moor Iron Works, New York, manufacturer of process equipment, boilers and welded steel products. All types of watertube boilers manufactured by the Edge Moor Iron Works are covered in the calalogue and important accessories such as water walls, air preheaters, and waste-heat boilers are briefly discussed.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davis

Smokestack Breeching

Q.—In regard to the layout of smokestack breechings, can the same method of layout be applied to a smaller stack or one of less than 22 inches diameter with flat seats on the boiler? J. L. T.

A.—The development of the breeching submitted with the question is shown in Practical Plate Development Article XIX.

The method of developing the breeching would be the same should the diameter of the stack be made less than 22 inches. Problem No. 15 of Practical Plate Development shows such a condition, the solution of which will appear in the January issue.

Locomotive Boiler Horsepower

Q.—In your Questions and Answers Department of BOILER MAKER AND PLATE FABRICATOR, I see that you give some very interesting and helpful information, and I wonder if you would publish the methods used to calculate the horsepower of an ordinary locomotive boiler which carries 200 pounds per square inch steam pressure. M. W. S.

A.—The question does not include the proper information for determining the horsepower of a boiler.

Boiler horsepower is taken as a measure of evaporation. One boiler horsepower is equal to the evaporation of 34.5 pounds of water per hour from and at 212 degrees F. For locomotive boilers, it is generally desirable to make the boiler and cylinder horsepower equal.

The following rules are based on cylinder and boiler horsepower and on proper evaporating values being assigned to firebox, tube and flue, arch tube and combustion chamber heating surfaces.

Horsepower = $0.02120 \times P \times A$ for saturated steam.
Horsepower = $0.02290 \times P \times A$ for superheated steam.

Where:

P = boiler pressure, pounds per square inch.
A = area of one cylinder in square inches.

Maximum horsepower is assumed to be reached at the following piston speeds:

Saturated steam— 700 feet per minute.
Superheated steam—1000 feet per minute.

The amount of steam required per hour, per horsepower is taken as follows:

Saturated steam = horsepower × 27.0 pounds.
Superheated steam = horsepower × 20.8 pounds.

The pounds of steam evaporated per hour per square foot of heating surface are taken as follows:

Firebox heating surface = 55 pounds per hour per square foot heating surface.
Combustion chamber heating surface = 55 pounds per hour per square foot heating surface.
Firebox watertubes = 55 pounds per hour per square foot heating surface.
2-inch tubes, 18 feet long, $^{15}/_{16}$-inch spaces = 9.54 pounds per hour per square foot heating surface (base figure).
$2\frac{1}{4}$-inch tubes, 18 feet long, $^{15}/_{16}$-inch spaces = 10.0 pounds per hour per square foot heating surface (base figure).

The values for tube heating surfaces vary with the spacing and length of the tubes. Various engineering handbooks give tables of evaporation for tubes and flues for various lengths and spacing.

Example:

A locomotive with 23-inch by 28-inch cylinders, using saturated steam at 200 pounds pressure:

Horsepower = $0.02120 \times P \times A$.
Horsepower = $0.02120 \times 200 \times 415.48$.
Horsepower = 1761.
Total steam consumption per hour = $1761 \times 27 = 47{,}547$ pounds.
Firebox area assumed to be 212 square feet with evaporation at 55 pounds: consumption = 11,660 pounds per hour.
47,547—11,660 = 35,887 pounds steam to be evaporated by tubes.
The heating surface area of one 2-inch tube, 20 feet long, after deducting for tube sheets = 10.423 square feet.
Tubes 2 inches diameter, 20 feet long, spaced ¾-inch rate of evaporation = 8.32 pounds per hour per square foot heating surface.
Evaporation for each tube = $10.423 \times 8.32 = 86.7$ pounds per hour.
Number of tubes required = $35{,}887 \div 86.7 = 414$.

With a given boiler, the problem reverts to obtaining the horsepower based on the actual heating surface of the boiler and comparing it with the cylinder horsepower based on the size of the cylinders and the boiler pressure.

The boiler horsepower based on evaporation should be at least equal to 100 percent of the cylinder horsepower.

Flue Sheet Braces and Staybolts

Q.—What would be the load in pounds per square inch on a front flue sheet brace of 1 3/16-inches diameter, supporting 80 square inches of a boiler 102 inches in diameter and carrying 220 pounds pressure per square inch. Please show figures in full showing how this is done.

Also show figures in full showing how to find the area of any size of a staybolt at the root of thread or at the reduced section, minus the area of the telltale hole.—J. G. M.

A.—The question does not include sufficient information on the type of brace used, or the manner in which the brace is connected to the tube sheet to give a complete answer. Using the information as given in the question, the problem resolves itself into determining the stress on a $1\frac{3}{16}$-inch diameter brace rod supporting 80 square inches of a front tube sheet, supporting 220 pounds boiler pressure, and is as follows:

The product of the net area in square inches multiplied by the maximum allowable working pressure in pounds per square inch, gives the load to be supported by the brace. Assuming 80 square inches to be the net area to be supported by the brace, the total load supported by the brace would be:

$80 \times 220 = 17{,}600$ pounds, load supported by brace.

The load on the brace in pounds per square inch, usually termed the stress on the brace in pounds per square inch, would be the total load on the brace divided by the net cross-sectional area of the brace.

The cross-sectional area of a $1\frac{3}{16}$-inch diameter brace would be:

$$3.1416 \times \left(\frac{1.1875}{2}\right)^2 = 1.108 \text{ square inches.}$$

The stress in pounds per square inch on the brace would be:

$17{,}600 \div 1.108 = 15{,}893$ pounds per square inch, total load or stress on the brace.

This load would be in excess of the maximum allowable stress for staybolts and stays or braces as provided for in the A.S.M.E. Power Boiler Code. The code provides as follows:

MAXIMUM ALLOWABLE STRESSES FOR STAYBOLTS AND STAYS OR BRACES

Description of staybolts and stays or braces	Stresses, pounds per square inch: For lengths between supports not exceeding 120 diameters[1]	For lengths between supports exceeding 120 diameters[1]
a Unwelded or flexible staybolts less than twenty diameters[1] long, screwed through plates with ends riveted over..........	7,500	....
b Hollow steel staybolts less than twenty diameters[1] long, screwed through plates with ends riveted over................	8,000	....
c Unwelded stays or braces and unwelded portions of welded stays or braces......	9,500	8,500
d Steel through stays or braces exceeding $1\frac{1}{2}$ inches diameter[1]	10,400	9,000
e Welded portions of stays or braces......	6,000	6,000

[1] Diameters taken at body of stay or brace

Assuming that the stay in question was an unwelded stay, the length of which exceeds 120 diameters, the diameter of the brace, in order to support the load as

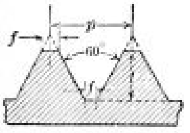

Fig. 1.—U. S. Standard Thread

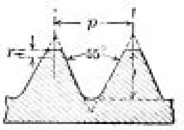

Fig. 2.—Whitworth Standard Thread

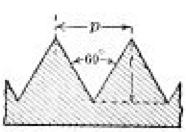

Fig. 3.—Sharp V Thread

given in the question and still stay within the maximum allowable stress on braces, would be calculated as follows:

Determine the required cross-sectional area of the brace, by first computing the total load to be carried by the brace, and dividing the total load, by the value of the allowable stress for unwelded braces for lengths between supports exceeding 120 diameters.

Total load on brace = 17,600 pounds.

Allowable stress on stay = 8500 pounds per square inch.

$17{,}600 \div 8500 = 2.07$ square inches.

Referring to any engineering handbook, we find that a $1\frac{5}{8}$-inch diameter brace has a cross-sectional area of 2.074 square inches. Thus, to support 80 square inches of surface, under a load of 220 pounds per square inch and stay within the allowable stress of 8500 pounds per square inch, a $1\frac{5}{8}$-inch diameter brace rod would have to be used.

Staybolts, generally, are either threaded with U. S. Standard, Whitworth or Sharp V-threads, with 12 threads per inch. The area at the root of the thread is found by obtaining the diameter at the root of the thread, as follows:

First obtain the depth of the thread from the following formulas:

U. S. Standard Thread (Fig. 1)

$$p = \text{pitch} = \frac{1}{\text{No. threads per inch}}$$

$$t = \text{depth} = \text{pitch} \times 0.6495$$

$$f = \text{flat} = \frac{\text{pitch}}{8}$$

Whitworth Standard Thread (Fig. 2)

$$p = \text{pitch} = \frac{1}{\text{No. threads per inch}}$$

$$r = \text{radius} = \text{pitch} \times 0.1373$$

$$t = \text{depth} = \text{pitch} \times 0.64033$$

Sharp V Thread (Fig. 3)

$$p = \text{pitch} = \frac{1}{\text{No. threads per inch}}$$

$$t = \text{depth} = p \times 0.750$$

then obtain the diameter at the root of the thread from the following formula:

$$D' = D - 2t$$

where:

D' = diameter at root of threads in inches.
D = diameter of staybolt in inches.
t = depth of threads in inches.

The area at the root of thread would then be:

$$\text{Area at root of threads in square inches} = \pi \times \left(\frac{D'}{2}\right)^2$$

where:

$\pi = 3.1416.$
D' = diameter at root of threads in inches.

From this area, the cross-sectional area of the tell-tale hole is then taken and the resultant area would be the least cross-sectional area of the staybolt.

Assuming for example, a staybolt 1-inch in diameter, 12 *V*-threads per inch, with a $\frac{3}{16}$-inch tell-tale hole, the least cross-sectional area would be:

first, obtain pitch of threads. (p)

$$p = \frac{1}{12}$$

$$p = 0.0833 \text{ inch}$$

then, obtain depths of thread. (t)

$$t = 0.0833 \times 0.75 = 0.062475 \text{ inch}$$

then, obtain diameter of root of thread.

$$D' = 1 - 2 \times 0.062475$$

$$D' = 1 - 0.124950$$

$$D' = 0.875 \text{ inch.}$$

then, obtain area at root of thread as follows:

$$\text{Area} = 3.1416 \times \left(\frac{0.875}{2}\right)^2$$

$$\text{Area} = 0.6013 \text{ square inch}$$

from this deduct the area of a $\frac{3}{16}$-inch diameter circle or:

$0.6013 - 0.02761 = 0.57369$ square inch area at root of thread with area of the tell-tale hole deducted.

The area at the reduced section is obtained by using the diameter of the staybolt at the reduced section. This diameter should be checked against the diameter at the root of the threads and whichever is the least should be used in obtaining the least cross-sectional area of the staybolt.

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States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
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States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Washington
Michigan	Oklahoma	Wisconsin

Cities

Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
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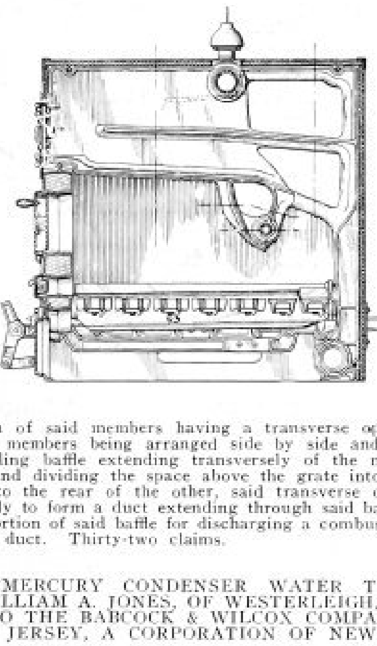
Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,868,445. BOILER. CHARLES W. BRABBEE, OF BRONXVILLE, NEW YORK, ASSIGNOR TO AMERICAN RADIATOR COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

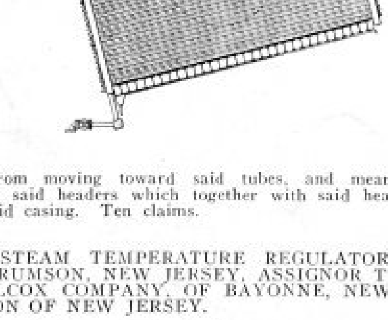
Claim.—A boiler comprising a grate, a plurality of sections arranged side by side, certain of said sections each having a depending water member communicating therewith and terminating at its lower end above



the grate, each of said members having a transverse opening, said depending water members being arranged side by side and cooperating to form a depending baffle extending transversely of the normal plane of said sections and dividing the space above the grate into two chambers arranged one to the rear of the other, said transverse openings alining communicatively to form a duct extending through said baffle, and means at the lower portion of said baffle for discharging a combustion supporting gas from said duct. Thirty-two claims.

1,864,737. MERCURY CONDENSER WATER TUBE STEAM BOILER. WILLIAM A. JONES, OF WESTERLEIGH, NEW YORK, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

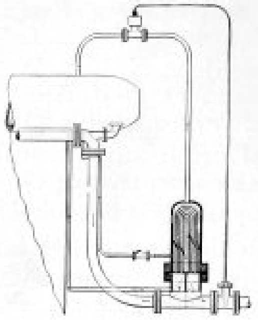
Claim.—A water tube boiler comprising tubes and headers, an air tight casing around said tubes attached to said headers, supports to prevent



said casing from moving toward said tubes, and means closing the spaces between said headers which together with said headers constitute the ends of said casing. Ten claims.

1,890,245. STEAM TEMPERATURE REGULATOR. JOHN E. BLACK, OF RUMSON, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

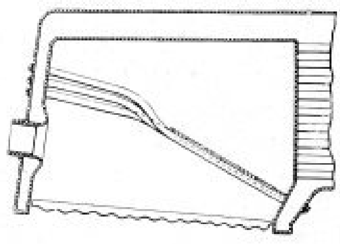
Claim.—In combination, a boiler having a steam space, a superheated steam pipe, a temperature regulator connected to said pipe and having a chamber beneath the normal water level of the boiler, means for maintaining a supply of water in the chamber, means for passing the steam from the pipe through the chamber while maintaining it out of contact



with the water therein, a connection from the upper part of said chamber to said steam space, two connections from the lower part of the chamber to the water space of the boiler, and means for causing a circulation through said water connections and chamber. Ten claims.

1,918,420. ARCH FOR BOILER FIREBOXES. ROBERT J. NEEDHAM, OF TORONTO, ONTARIO, CANADA.

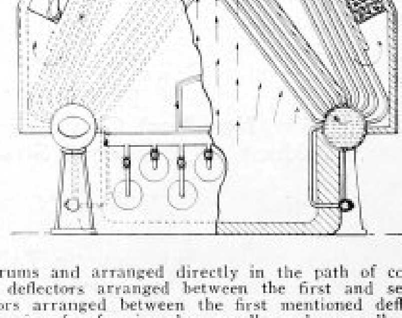
Claim.—In a locomotive boiler firebox, a baffle arch structure dividing the firebox into a combustion chamber and a furnace chamber and comprising a series of water tubes having spaced parallel brick-supporting reaches and reaches laterally converged and disposed in superposed posi-



tions to provide increased communicating space between said combustion chamber and furnace chamber; and bricks supported by said parallel reaches of the tubes and closing the spaces therebetween. Eleven claims.

1,917,617. STEAM BOILER. HENRY A. ULRICH, OF LOS ANGELES, CALIFORNIA.

Claim.—A steam boiler comprising a casing, a fire box in said casing, means for heating the fire box, a pair of parallel steam drums arranged in the casing directly above the fire box, lower drums arranged in the casing adjacent the fire box, downwardly and outwardly extending banks of tubes connecting the steam drums to the lower drums, diagonally extending and inter-crossing banks of tubes connecting the lower drums to



the steam drums and arranged directly in the path of combustion from the fire box, deflectors arranged between the first and second banks of tubes, deflectors arranged between the first mentioned deflectors and the walls of the casing for forming downwardly and upwardly extending passages with the first mentioned banks of tubes arranged in the downwardly extending passages, means connecting the upwardly extending passages to a smoke stack, feed water heating means in the upwardly extending passages and connected to the steam drums, a steam collecting drum arranged in the casing between the steam drums, a series of tubes connected to the steam drums throughout the lengths thereof and to the steam collecting drum, a superheated steam outlet header arranged below the steam collecting drum, and superheated tubes connecting the steam collecting drum with the super-heated steam outlet header and extending downwardly through the second mentioned banks of tubes. One claim.